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Bulletin 16

Upper Devonian Pelecypods of the New York Chemung Stage

by

A. Lee McAlester

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PEABODY MUSEUM OF NATURAL HISTORY
YALE UNIVERSITY
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BY
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Peabody Museum of Natural History
and
Department of Geology,
Yale University

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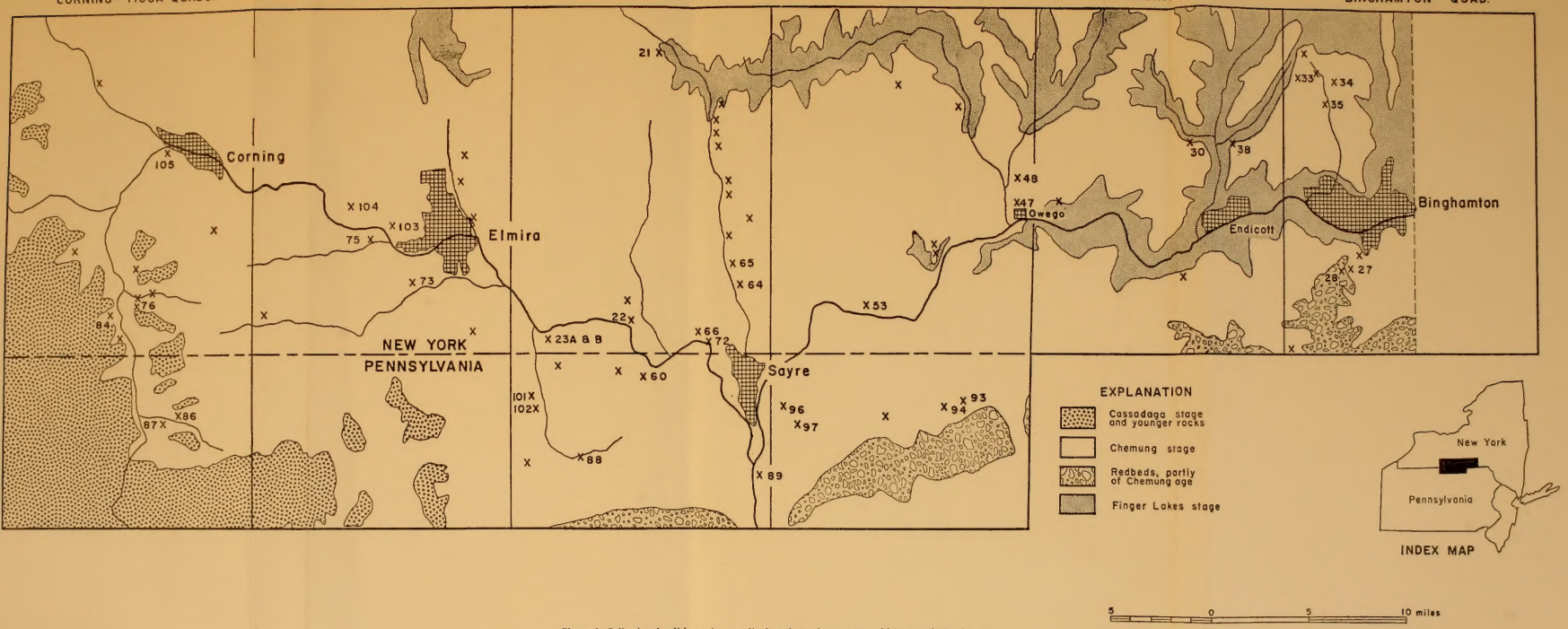

Figure 1. Collecting localities and generalized geology. Outcrops at which no pelecypods were found are marked but not numbered. Geology from: Pepper and de Witt, 1951; Williams and Kindle, 1909; Geologic map of Pennsylvania, 1932. Boundaries are grossly projected in the Binghamton quadrangle and in Pennsylvania.

CONTENTS

ABSTRACT 1
INTRODUCTION 2
STRATIGRAPHIC AND GEOGRAPHIC SETTING
Status of New York Upper Devonian stratigraphy 4
Stratigraphic nomenclature 5
Geographic and stratigraphic distribution of the fauna 5
INTERPRETIVE CONCLUSIONS
Previous work and necessity for species revision 8
Genera and higher categories 11
REMARKS ON SYSTEMATICS
Preservation of the fauna 13
Doubtful forms not included 13
Laboratory techniques 13
Notes on the descriptions 14
SYSTEMATIC PALEONTOLOGY
Nuculoid genera
Palaeoneilo 16
Nuculoidea 21
"Nuculana" 23
Parallelodont genus
Grammatodon (Cosmetodon) 24
Pterioid genera
Actinopteria 26
Leiopteria 29
Leptodesma 31
Cornellites 35
Mytiloid genera
Mytilarca 38
Myalina 40
Ptychodesma 41
Goniophora 42
Modiomorpha 44
Glossites 45
Spathella 47
Pectinoid genera
Pseudaviculopecten 48
Lyriopecten 51
Pterinopecten 54
Vertumnia 56
Possibly edentulous genera
Grammysioidea 57
Grammysia 59
Sphenotus 61
Cimitaria 63
Edmondia 64

SYSTEMATIC PALEONTOLOGY (continued)

Schizodont genus
Eoschizodus 66
Heterodont genera
Cypricardella 68
Cypricardinia 70
LOCALITY REGISTER 72
REFERENCES CITED 76
INDEX 83
Plates 1-32 at back of book

UPPER DEVONIAN PELECYPODS OF THE NEW YORK CHEMUNG STAGE

By A. Lee McAlester

ABSTRACT

The Upper Devonian rocks of New York and northern Pennsylvania provide perhaps the world's best opportunity for understanding the late Devonian pelecypods, because only in this region, among all well-known Devonian exposures, was deposition relatively continuous in the clastic marine facies which is characterized by prolific pelecypod faunas. This study is a systematic revision of the pelecypod faunas of the Chemung stage (Cooper, 1942) which includes about one-fourth of New York Upper Devonian rocks.

Approximately 2,500 specimens representing 36 Chemung stage localities were collected for the study, and these provide the bulk of the evidence on which the revision is based, although paratype material is redescribed for a few rare species. Holotypes are designated and refigured for all previously described Chemung stage species for which type material is available.

The revision has shown that the earlier species were grossly oversplit and were therefore biologically meaningless. Of the 47 species recognized in the study, 5 are newly discovered and 10 are considered to be too poorly known to warrant specific names. There remain 32 valid Chemung stage species which had been previously named. For these 32 names there are a total of 74 suggested synonyms, 64 of which are first proposed here. This is an average of more than two synonyms for each previously described species. In short, 106 species names have been previously used for what are probably only 32 species. Most of the Chemung stage species are therefore very "new" in definition even though only five new names were necessary in describing the fauna. The new species described are: *Myalina? newelli, Goniophora cayutensis, Pseudaviculopecten bradfordensis, Sphenotus tiogensis,* and *Cypricardinia larocquei.*

The study indicates also that comprehensive generic-level revisions are urgently needed in early Paleozoic pelecypods, and for this reason most of the generic names used are very tentatively applied to the Chemung species. Only informal higher categories (nuculoid, parallelodont, pterioid, mytiloid, pectinoid, possibly edentulous, schizodont, and heterodont) are used for grouping the genera.

INTRODUCTION

The foremost authority on molluscan biology has recently written: "Although [the pelecypods are] so simply constructed . . . few groups of animals are more successful. In none are the diverse courses of evolutionary change easier to trace" (Yonge, 1958, p. 4). In view of such statements, it is surprising that no acceptable phylogeny has yet been proposed for the group and that students of pelecypod systematics universally denounce the inadequacies of all previously suggested classifications. Workers on both fossil and living pelecypods seem convinced that the present impasse in pelecypod phylogeny and systematics cannot be fully resolved without more historical evidence, especially evidence from the Paleozoic era when the major pelecypod adaptations seem to have first arisen. Paleontologists further agree that the Paleozoic clams are among the most seriously neglected of the major fossil groups. These contradictions first led to my interest in studying Paleozoic pelecypods.

Because Dr. Norman D. Newell had already made a monumental start toward an understanding of the late Paleozoic pelecypods, I felt that the most urgent neglect was in the pre-Carboniferous forms. With this preference in mind, my research adviser at Yale, Professor Carl O. Dunbar, suggested that the prolific and accessible Upper Devonian pelecypods of New York were ripe for restudy. Much had been learned of New York Devonian stratigraphy in the century since James Hall began his classic studies of Devonian clams, and it would now be possible to establish generalized time ranges for Hall's species. In addition, we expected that Hall's systematics would benefit from a review in the light of biological principles which have grown up since his works appeared, an expectation that was amply confirmed as the study progressed. We hoped also that these systematic revisions would provide the basic data for later evolutionary, ecologic, and biostratigraphic interpretations. A compelling consideration was the knowledge that New York provided perhaps the world's best opportunity to understand the middle and late Devonian clams, for only there, among all well-known Devonian exposures, was deposition relatively continuous in the clastic marine facies which is characterized by prolific pelecypod faunas.

So great were Hall's efforts, that from the beginning it was obvious that a restudy of even his Upper Devonian species would require many years. With the advice of Drs. Donald Fisher and Lawrence Rickard of the New York Geological Survey, we decided to begin with a revision of the large fauna of the classic Chemung type region, an area of about 2,000 square miles roughly bounded by the triangle formed by the cities of Elmira, Binghamton, and Ithaca. This restricted the study in both geologic time and area to about one-fourth of the New York Upper Devonian. The rocks covered were the Cayuta and Wellsburg "formations" which make up the pelecypod-bearing part of the Chemung stage, the second oldest of the four Upper Devonian stages recognized by Cooper (1942). Much of Hall's Upper Devonian material came from this unit, as did most of the Upper Devonian specimens first described by Conrad, and thus nomenclatural difficulties were minimized by beginning with the faunas of the Chemung stage.

Because most of the early collections had poor locality data and also because they are now scattered among many museums, I wanted to base the revision on as

much new material as possible. The summers of 1957 and 1958 were therefore spent collecting in the Chemung stage of New York and adjacent Pennsylvania. My goal was to try to collect from every substantial outcrop within the exposure area of the stage, but many were doubtlessly missed.

The several tons of material collected yielded, after final preparation, over 2,500 identifiable pelecypods, all of which are permanently deposited in the Yale Peabody Museum. These, supplemented by a dozen or so excellent specimens collected by Professor Edward I. Leith for the Yale Peabody Museum in the early 1930's, provide the bulk of the evidence on which this revision is based, although paratype material is redescribed for a few rare species. Holotypes are designated and refigured for all previously described Chemung stage species for which type material is available.

Laboratory work was done at Yale during the academic years of 1958-59 and 1959-60 and during the summer of 1959. The Hall collections at the American Museum of Natural History and the New York State Museum were examined in December, 1959.

Among those to whom I am indebted for discussion and advice are: Dr. Norman D. Newell of the American Museum of Natural History and Columbia University; Drs. Donald W. Fisher and Lawrence V. Rickard of the New York Geological Survey; Dr. Robert G. Sutton and his enthusiastic students of the University of Rochester; Mr. George W. Colton of the U.S. Geological Survey; Drs. Karl M. Waage and John E. Sanders of the Yale faculty; and Dr. Joseph T. Gregory, formerly of Yale and now at the University of California at Berkeley.

I am also most grateful to Dr. Newell at the American Museum and Drs. Rickard and Fisher, as well as Mr. Clinton F. Kilfoyle, at the New York State Museum for the loan of types and for many kindnesses during my visits to their institutions. The devoted and efficient care that Hall's valuable collections are receiving under these men should serve as an example for museums everywhere.

The field work was supported in 1957 by a grant from the Charles Schuchert Fund of the Division of Invertebrate Paleontology, Peabody Museum, Yale University and in 1958 by a stipend from the Pan-American Petroleum Corporation Fellowship of the Department of Geology, Yale University. My brother, Donald J. McAlester, served as an able field assistant during the summer of 1957.

Finally, my greatest debt is to Dr. Carl O. Dunbar, who not only suggested the problem but also introduced me to the New York Devonian rocks in the field and continually encouraged the study by his teaching, both in and out of the classroom.

This study was submitted in May, 1960, as a dissertation for the degree of Doctor of Philosophy at Yale University.

STRATIGRAPHIC AND GEOGRAPHIC SETTING

Status of New York Upper Devonian Stratigraphy

The well-established general pattern of a westward shift of contemporaneous facies in the "Catskill Delta" is too familiar to require summary here (a good, brief discussion is given by Dunbar and Rodgers, 1957, p. 137-140). Because of the necessarily generalized treatment in elementary textbooks, however, many geologists seem to believe that these classic rocks are among the world's best understood. Nothing, in my opinion, could be farther from the truth, particularly in regard to the detailed relations in the Upper Devonian part of the delta. Here, as elsewhere, many generations of stratigraphers have avoided restudying a "well-known" region, even though stratigraphic theory and technique have undergone revolutions which invalidate most of the pioneer work. Only during the past ten years has a healthy rebirth of interest countered this trend in the New York Upper Devonian, and now, for the first time, stratigraphic interpretations in these rocks are being substantiated by detailed presentation of field evidence (see references cited under the names: Colton, de Witt, Pepper, and Sutton.)

In reviewing the evidence on which the "Catskill Delta" facies concepts are based, I have been struck by one seldom stressed but critical fact: *most modern knowledge of the facies relations and correlations has arisen from the field tracing of key lithologic horizons from one facies to the next.* This fact has great importance for paleontologic studies because the prolific faunas begin at precisely the point where the most persistent key horizons, the western black shales, begin to thin and disappear. This disappearance of key horizons makes correlations within the richly fossiliferous facies extremely difficult, and, for this reason, most of the modern stratigraphic work has been confined to the relatively unfossiliferous western facies. The paleontologist is still confronted by the stratigraphically impregnable combination of thick, monotonous lithologies exposed in small, widely scattered outcrops in a region of very gentle dips.[1]

Nowhere is this difficulty more evident than in the 1,200 feet of monotonously uniform sandstones, siltstones, and shales which make up the Cayuta and Wellsburg "formations" which, in turn, comprise the richly fossiliferous facies of the Chemung stage of Cooper (1942; see also the following discussion of nomenclature). For the present study, I have been able to establish only generalized stratigraphic positions for the localities by methods discussed below, but the recording of precise locality data will make it possible to reinterpret the faunas in the light of future stratigraphic revisions. I do not regard this as an overwhelming difficulty, however, because the relatively slow evolutionary change of the pelecypods coupled with the short time probably required for deposition of the

---

[1] Dr. Robert G. Sutton and his students at the University of Rochester are conducting an unusually thorough and imaginative program of stratigraphic study on the fossiliferous Finger Lakes and Chemung stage rocks. They report in discussions (1959) that consistent heavy mineral zones and brachiopod horizons can be traced through the fossiliferous facies, the heavy mineral horizons even extending into the non-marine "Catskill facies" rocks. These discoveries mark an extremely significant break-through and promise to enhance greatly our understanding of Upper Devonian stratigraphic relations.

Chemung stage rocks make it possible to assume relative geologic contemporaneity for most of the Chemung stage localities.

Stratigraphic Nomenclature

The terminology for time, rock, and facies units in the New York Upper Devonian is presently in a state of chaotic flux (see, for example, the conflicting opinions in Caster, 1933, 1934; Cooper, 1942; Grossman, 1944; Pepper and others, 1950, 1951, 1956; Tesmer, 1955; Fisher, 1956; Sutton, 1959; and de Witt and Colton, 1959). A new and very detailed correlation chart of the New York Devonian is now (1960) being prepared by Dr. Lawrence V. Rickard of the New York Geological Survey and this should soon provide a sound basis for nomenclatural revision. Meanwhile, I have adopted several arbitrary nomenclatural expedients.

The nomenclature for time and time-stratigraphic units follows Cooper (1942), in which four stages are recognized in the Upper Devonian. Note that Cooper redefines the venerable name "Chemung" as a time-stratigraphic unit (Chemung stage). The term is used only in this time-stratigraphic sense in the present report.

In rock-stratigraphic terminology, the units involved here are the Cayuta and Wellsburg "formations" of Cooper (1942). These names were first proposed by Williams (1906) as informal, loosely defined members of a more inclusive "Chemung formation," the Wellsburg member being sandier and less fossiliferous than the underlying Cayuta member. To my knowledge, a boundary between them has never been shown on a published map at any scale. Pending demonstration of their usefulness as "laterally traceable lithologic genetic units" (American Commission on Stratigraphic Nomenclature, 1956), I feel that the names should be avoided or used only as informal members of a more inclusive formation. No name is now available for this formation and future revision will require either a new name or a redefinition of an old one. For the present study, I have avoided rock-stratigraphic nomenclature because the time-stratigraphic term "Chemung stage" is adequate for paleontologic discussion. It should be emphasized, however, that the richly fossiliferous facies of the stage is the principal concern here.

Geographic and Stratigraphic Distribution of the Fauna

The geographic and stratigraphic distribution of the pelecypod specimens of the Chemung stage is summarized in fig. 1 and tables 1 and 2. A few notes are necessary in explanation of the figure and tables:

The index map (fig. 1, frontispiece) shows the location of all outcrops of the Chemung stage which were visited in the field. Those at which pelecypods were found are numbered on the map; others are marked merely by crosses. Precise data on each numbered locality are given in the Locality Register.

The boundaries shown on the map are necessarily much generalized. The lower stage boundary in New York was drawn at the first appearance of *"Spirifer disjunctus"* as mapped by Williams and Kindle (1909). This boundary was grossly projected eastward into the Binghamton 15-minute quadrangle, which was not included on Williams and Kindle's map. After the systematic revision was completed, I learned in conversations with Robert Sutton that his mapping shows Williams and Kindle's boundary to be about 150 feet low in the area north and west of Binghamton. This means that localities 30 and 38 are probably well down in the Finger Lakes stage, instead of being at the Chemung-Finger Lakes bound-

ary as shown by the earlier mapping. In interpreting the occurrences, specimens from localities 30 and 38 should be considered as coming from the uppermost Finger Lakes stage.

The upper boundary of the stage in New York has been placed at the base of the Perrysburg formation, as mapped by Pepper and de Witt (1951), because this horizon probably roughly approximates the first appearance of the *"Athyris angelica"* fauna which defines the base of the Cassadaga stage in the more fossiliferous post-Chemung rocks to the south and west. No usable mapping exists for the adjacent area in Pennsylvania, and the boundaries shown there are highly subjective projections. Only Pennsylvania localities near the border of New York were collected because of this complete lack of stratigraphic data.

	West					East
	Corning-Tioga quads.	Elmira-Troy quads.	Waverly-Sayre quads.	Owego-Towanda quads.	Apalachin quad.	Binghamton quad.
Upper Chemung Stage	76					
	84,86					
	87					
Middle Chemung Stage	105	103,104	65,88			28
		75	22,64,66, 101, 102			27
		73	23A,23B, 60, 72	47,48,53, 97		
Lower Chemung Stage						33
			89	93,94,96		34,35
			21		30,38	

Table 1. Inferred relative stratigraphic position of Chemung stage pelecypod localities.

Table 1, which shows generalized stratigraphic positions for the localities, is a subjective compilation based on: 1) elevation, 2) nearness of locality to mapped stage boundary, and 3) relative structural position as shown on the greatly oversimplified structural contour map of Wedel (1932; compare Wedel's map with the very detailed structural mapping of Bradley and others, 1941, which regrettably covers only the extreme western part of the fossiliferous outcrop of the Chemung stage). The accuracy of the chart is probably sufficient to permit the placing of a locality in only the lower, middle, or upper third of the 1,200 feet of Chemung stage rocks and only such general conclusions are made from it. For reasons noted

LOCALITY	UPPER CHEMUNG STAGE				MIDDLE CHEMUNG STAGE																			LOWER CHEMUNG STAGE										Nichols area	Montrose, Pa.	Near Elmira	Total specimens per species	Total localities per species
	76	84	86	87	105	103	104	65	88	28	75	22	64	66	101	102	27	73	23A	23B	60	72	48	47	53	97	33	89	93	94	96	34	35	21	30	38					
Palaeoneilo constricta	1	1	3	6		2				3	2	7		9	1	3	1	4	2	5					1		2	5		3	1	29	31		23	25				170	24
Palaeoneilo bisulcata		1		1						3	3	1		3		4				4											7	2							29	10
Palaeoneilo angusta			1	1					1			4		3		5			1								3												19	8
Nuculoidea corbuliformis				1		1					1	1		5		21		4		13										1		2		7	32				89	12
"Nuculana" rostellata?																10																							10	1
"Nuculana" sp.										2																													2	1
Grammatodon (Cos.) chemungensis			4	1							59	3								1	3																	71	6
Actinopteria boydi					1		1							7					1																				10	4
Actinopteria sp. A				2								1																											3	2
Actinopteria sp. B		4																																					4	1
Leiopteria nitida						1						1	1	9				1		7										15		1		6	15				57	10
Leptodesma naviforme																																			60	181				241	2
Leptodesma spinigerum		9	12	15		7			4	5	10	95		95	10	525		40		185					11					80	10							1113	16
Cornellites chemungensis								4				21	3	21				1	8			3			42		3		1								8		115	11
Mytilarca chemungensis				3		2					28	10		10							6																	59	6
Myalina? newelli, n.sp.																			3						2						4							9	3
Myalina? sp.				1										1																									2	2
Ptychodesma neglectum				1							24	3		1				1	1	1																		32	7
Goniophora chemungensis														5				1		1					1		1			1				3	18			31	8
Goniophora cayutensis, n.sp.				1				2																															3	2
Goniophora sp.												1		3						3																			7	3
Modiomorpha mytiloides														5																									5	1
Glossites depressus												1		7																	1								9	3
Spathella typica			2	3							4	5		3				1	3	1							1				2							25	10
Pseudaviculopecten striatus											5	1		2						2																			10	4
Pseudaviculopecten fasciculatus														2								2																	4	2
Pseudaviculopecten bradford., n. sp.														1																	1								2	2
Lyriopecten tricostatus											3			6		1	1		1													1							13	6
Lyriopecten anomiaeformis														1					1				1								3	1							7	5
Lyriopecten magnificus																																					1			1	1
Pterinopecten strictus						2					3																						1							6	3
Pterinopecten suborbicularis	2											1																												3	2
Vertumnia reversa			1	1							1	2		5										1	2														13	7
Grammysioidea subarcuata						2																			2														4	2
Grammysioidea sp.																			2																				2	1
Grammysia elliptica																											1				1	1			3				6	4
Grammysia sp.																												1											1	1
Sphenotus tiogensis, n.sp.			4	14			1				3	1			1	6		2		1					1					3		6	14			1			58	14
Sphenotus sp.																																						1		1	1
Cimitaria angulata														2																									2	1
Edmondia philipi		1	4	13						2	1	9		12					2	1					1		1			1	1	12			2				63	15
Eoschizodus? chemungensis		1		1								5		4													3												14	5
Cypricardella bellastriata		6	7	4		3					2	9		21				2	3	2		1				4	1	16		4	2								70	14
Cypricardella gregaria																											1	16				28	16		53	53				167	6
Cypricardinia larocquei, n.sp.																					5																			5	1
Cypricardinia sp. A																																								1	1
Cypricardinia? sp. B																		3		5																			8	2
Total specimens per locality	3	23	38	69	1	20	2	6	5	15	149	182	4	243	12	575	3	59	28	232	14	6	1	1	52	15	13	25	1	107	17	93	68	1	154	328	8	1	2	2576	—
Total species per locality	2	7	9	17	1	8	2	2	2	5	15	21	2	26	3	8	3	10	12	15	3	3	1	1	8	2	8	4	1	7	7	10	8	1	7	8	1	1	2	—	—

Table 2. Distribution of Chemung stage pelecypod specimens.

earlier, I do not, however, feel that this seriously restricts an understanding of the pelecypods of the Chemung stage.

The final table (table 2) shows the number of specimens of each species found at each locality. It includes only my own collections plus a few specimens in the Yale Peabody Museum collected by E. I. Leith. Exceptions are made for four species which were unrepresented in my collections: *Lyriopecten magnificus, Cimitaria angulata, Sphenotus* sp., and *Cypricardinia* sp. A. Each of these species is known only from one or two specimens described by Hall. In preparing the chart, the localities were listed by stratigraphic position with the younger localities to the left. This arrangement also approximates an east-west geographic listing, because the localities tend to become progressively younger from east to west.

INTERPRETIVE CONCLUSIONS

Previous Work and Necessity for Species Revision

Almost nothing has been published on Chemung stage pelecypods since the appearance of James Hall's classical monographs, which included all of the New York Upper and Middle Devonian pelecypods (Hall, 1884c, 1885). These monumental works incorporated the few earlier descriptions of Chemung stage specimens and thus only Hall's publications need be considered in discussing previous work on Chemung stage pelecypods.

In 1886, the year after the appearance of Hall's final volume, Henry Shaler Williams, who was then teaching at Cornell, published a six-page note in the American Journal of Science entitled: "Devonian Lamellibranchiata and Species-making." In it he summarized the involved history which preceded the final publication of Hall's work and this summary deserves to be quoted here at length:

> "The second portion of Professor James Hall's monograph on Devonian Lamellibranchs has been recently published, thus completing volume v, Part 1 of the Palæontology of New York. The first portion [published in 1884] was devoted to the Monomyaria. This second volume is devoted to the Dimyaria, is dated 1885, contains pages i to lxii, and 269 to 562, and plates xxxiv to xcvi with interleaved explanations of plates. . . . The first part of the volume, published in 1883, contains pages i to xviii, 1 to 268, and Plate I to XLVI. The complete work contains 642 pages and 96 plates, and it figures and describes 520 species and 65 genera. It is a magnificent work, placing before the student figures and descriptions of all the known species and varieties of the Devonian Lamellibranchiata of Eastern United States; it will take its place among the indispensable monographs on the table of the working paleontologist.
>
> "The illustration of these Lamellibranchs, as a whole group, was begun in 1869-70, in the issue of a pamphlet, called Preliminary Notice of the fossil Lamellibranchiata, etc., No. 2, 80 pages of which appeared, and a few copies of which were distributed in 1869. [This was a preliminary report for the "Dimyaria" volume which was finally published in 1885.] The title page of this pamphlet contained no author's name, it was accompanied by no plates [see Cooper, 1931]. In 1884, Preliminary Notice No. 1 appeared in the 35th Report of the Regents on the State Museum. [This was the preliminary "Monomyaria" report. Note that the final report on this group appeared in the same year.]
>
> "The final text and plates of the part on Monomyaria appeared in 1883 [1884]; and, finally, the part on the Dimyaria was published in 1885. In the meantime the Report of the State Geologist to the Legislature for 1882 (published in 1884, Assembly Documents 1882, vol. vii, No. 32), announced and published the diagnoses of 20 genera, all of which were new or restrictions of old genera, and, with the text were issued eleven plates of generic illustrations, in the explanation of which 54 genera and 134 species are named. Most of the plates of this double volume were completed several years before their publication, or before the text was finished. As early as 1874 sets containing a considerable number of the plates, with manuscript names, were sent out to Messrs. S. A. Miller, Dr. J. J. Bigsby, J. Barrande and Henry Nettleroth. (See plates and explanations, 1883, Preface, pp. 1 and 2.)
>
> "Mr. Miller published in his American Paleozoic Fossils, 1879, the names of these new species with reference to the forthcoming work, apparently under the advice and supervision of the author. Dr. Bigsby also published in 1878 the names attached to

these plates in his Thesaurus Devonico-Carboniferous. Thus a large number of new names became quoted with references to author and plate and figure and locality, before the text was even in the hands of the printers, reference being made to plates, but no mention of the fact that they were manuscript names.

"This action aroused serious criticism, although little was made public. And, although the author doubtless expected to get the volume out very soon, it was not till 1883 that paleontologists received the plates. So much impatience was evident that the author, being unable to persuade the Legislature to publish the volume, bought a hundred sets of the plates and distributed them in 1883 to the chief institutions and workers interested in the subject in this country. With the plates were given printed explanations of plates, and the announcement was made that the text was ready and in the hands of the printer.

"Much confusion and annoyance has arisen from this preliminary distribution of plates, and *publication* of names so long (at least seven years) before the regular publication of the text and plates."

Williams' purpose in writing, however, was not historical review but critical attack on the taxonomic philosophy underlying the work of Hall who was then, at the age of 75, the Grand Old Man of American paleontology. Williams continues:

". . . impatience naturally becomes extreme when we look at the prodigious amount of alteration which has been made in the identification, both specific and generic, in the plates illustrating the fossils supposed to be representative types. Comparison of the plates and explanations issued in 1883 with the text and plates issued in 1885,—the plates being the same with a few additions in the latter,—reveals the following facts. [I have made no detailed check of Williams' figures, but they are certainly of the correct order of magnitude.]

"In the first set of statistics, I have compared only those species and genera both of which, in both works, were already fully described when the first work was issued in 1883. The changes made in identification of the figures, representing 284 species and 47 genera (the plates being identically the same) were 81 in number as regards the genera, and 128 as regards the species.

"If now we consider the figures which were referred in 1883 to old species, and in 1885 to new species, we find 96 cases, and of figures placed in old genera in the first case and changed to new genera in 1885, we find 117 cases.

"Looked at from another point of view, and eliminating from the problem all matter added in 1885 and all specific and generic names not fully described and used *before* the first publication, 1883, there were made 209 changes of identification for 205 species under consideration.

"If we take the plates published in the Report of the State Geologist to the Legislature for 1882, printed in 1884, and compare the identification of the figures, which are there reproductions of those in the text and plates of 1885, a similar set of discrepancies appears.

"This Report was issued, professedly, as an official illustration of generic types or representative species of those genera, and 34 genera were illustrated; when we compare it with the final report, published only one year later, we find 19 cases of changed generic identifications, or, proportionate to the number of genera 50% and 24 specific changes or nearly 35%.

"Both these works, the plates and explanations, 1883, and the generic illustrations, 1884, were issued by the State Geologist as authoritative works illustrating the typical specimens described mostly by him, in the State collections; specimens which had been picked out as typical for the draughtsman, and not only had they been identified by him, but they had been used in the very description of genera and species for the illustration of which they were published.

"In the final work, 1885, their generic and specific names are changed, in most cases with no reason given, occasionally with the note 'by error' inserted in the list of synonyms. These alterations are not a simple few, but for the plates and explanations, there is an average of one alteration of identification for every species in the book. There is no disputing the facts; anyone can find them by mere comparison of the two volumes.

"It seems impossible to suppose that such errors could be due to carelessness of observation; the life-time experience of the author, and his acknowledged first rank among paleontologists forbid such an explanation, and we have no reason to suppose that the identifications are not in all cases his own.

"The only explanation we can conceive of is found in the system itself upon which the species are conceived and defined. Species-making and illustrating fossil forms are not the same thing. To have good figures of the most perfect typical fossil forms is of the greatest value to the student of paleontology but, if they are classified into species and genera it is all important that the differentiating characters should be discernible, at least on the typical specimens, and that too, not by experts only, but by any ordinary intelligent observer . . .

". . . [In a] new genus, for which about a score of species are defined, the writer has seen a series of specimens, picked out of a single block of stone, expressing, by almost imperceptible gradation, almost every character exhibited by the whole range of species figured except difference of size.

"The evil of this species-making habit is only aggravated by the minuteness and carefulness of the observer, and in the study of fossils it is particularly aggravated by the rarity of good specimens and the imperfection of the characters expressed. In its extreme it has ceased to be a classifying of organisms, or even fossils, and has become merely a narration of the differences exhibited by specimens.

"And when a student seeks to identify new material, the more careful his scrutiny, the more surely is he driven to the idea that specimens which do not fit any of the given descriptions must be new species. So long as the Cuvierian school prevailed, there was some excuse for the practice, but in this age when the belief in the fixity of specific characters and limits is shown by theory and observation to be erroneous, there is no reason for neglecting the element of variability as a factor in the classification and definition of organisms, whether living or fossil.

"The practice of differentiating species (and genera) by characters which are not clearly discernible on every fair set of the representatives of the species, or by characters which in point of variability among individuals from the same locality exceed the extent of modification separating two species of the same genus, is scarcely defensible, and leads to more confusion and uncertainty than if merely numbered photographs were distributed as illustrative of the fossils of each period and locality. If such rules were thoroughly heeded by working paleontologists the crop of new species would dwindle, but the species which were entitled to live would be capable of distinct definition and recognition.

"Species and genera can scarcely be called good, so long as the author himself is unable to distribute the typical specimens, twice alike, without reference to the original labels."

These are strong words, and in reading Williams' comments before beginning this study, I was inclined to dismiss at least some of his criticism as being overenthusiastic. As the revision progressed, my scepticism diminished. I believe that analysis of morphologic variation in the many large samples available to me has proved conclusively that the earlier species *were* grossly oversplit and were therefore biologically meaningless. I regard the evidence for this to be the major contribution of the present study.

More specifically, of the 47 species recognized here, 37 are considered to be

well-known enough to warrant specific names. Omitting the five newly discovered species, there remain 32 species which had previously been named. For these 32 names there are a total of 74 suggested synonyms, 64 of which are first proposed here. Of the 74, 39 are considered definite and 35 are questioned pending restudy of topotype material (in most cases these are not Chemung stage species). This makes an average of *more than two synonyms for each previously described species.* In short, 106 species names have been previously used for what are probably only 32 species. Most of the Chemung stage species are therefore very "new" in definition, even though only five new names were necessary in describing the fauna.

Finally, in fairness, it must be strongly emphasized that Hall's work was an above average example of the paleontology of its day. When it was begun, the "Origin of Species" had just appeared, and Hall can hardly be blamed for not appreciating concepts of population systematics that are only now becoming generally accepted almost a century after he wrote. The surprising thing is not that such work was done in 1869, but that so much of it persists today.

Even the precocious H. S. Williams later lapsed into nomenclatural abuses which make Hall's seem harmless. As examples drawn from his pelecypod work, see first the treatment of the Lower Devonian Chapman sandstone species in Williams and Breger, 1916. In this volume the authors name 51 species and varieties of clams, 39 of them being new. A quick count shows that of these new taxa, 26 are based on single poorly preserved specimens and this includes the type species of two new genera. An additional seven species are based on two specimens, which means that 85 percent of the new species and varieties were founded on only one or two poor specimens! Judging from the figures, I would not attempt even generic identifications of most of these specimens. The work is quite valuable, however, in giving detailed historical reviews for many Devonian pelecypod genera.

As an ultimate extreme of nomenclatural enthusiasm, see Williams' little fantasy on the Maine Silurian specimens of *Nuculites* (Williams, 1917). The principal contribution of this work, in which 19 new species of the genus were proposed, is best summarized by quoting the author who stated (p. 53): "In order to distinguish such species [based on distorted specimens] from those fossil species which preserve their original characters, I propose to call them METAMORPHIC SPECIES. . . . In the present paper I have assigned names selected from classical mythology to those species which seem to me to come under this definition of metamorphic species. They are of importance to the paleontologist in defining the fossil contents of formations. . . ."

Genera and Higher Categories

I have emphasized the necessity for species-level revision in the New York Devonian pelecypods, but the need is much broader than that. Aside from a scant half-dozen or so modern works, all the voluminous literature on Ordovician, Silurian, and Devonian clams suffers in varying degrees from the approach typified by the pioneer work of Hall and Williams. Most paleontologists would, I believe, concede that any evolutionary, ecologic, or biostratigraphic interpretation must rest ultimately on biologically sound definitions of species. Granting this, then the need for wholesale species-level revisions of the early Paleozoic pelecypods is abundantly evident.

At the species level, modern revision is, however, only a pressing need. At the

generic level, it is an urgent necessity. This study has convinced me that it is now all but impossible to apply a meaningful generic name to a Devonian pelecypod. Let me explain this further.

Most of the generic names for Paleozoic pelecypods have been proposed in studies of local faunas. Such work is ordinarily undertaken to provide paleontologic evidence for local stratigraphic interpretations, usually within a single geologic system. While this kind of study may lead to meaningful genera in rapidly evolving groups, it has served only to create generic chaos in the rather slowly evolving pelecypods. The unavoidable reason for this is clear: a man doing such a study can seldom be familiar with the detailed paleontologic literature on every animal group for each period and each continent. Given a widely distributed genus originating, say, in the Ordovician and surviving until the Permian (a not unreasonable range for pelecypod genera), the possibilities for subjective synonymy are staggering. Add to this the usual overenthusiastic taxonomic splitting plus the almost complete lack of generic-level revision, and the chaos of the present situation becomes evident. I regard objective generic restudy, along the lines so successfully undertaken for the Paleozoic gastropods by J. Brookes Knight, to be the most urgent need in Paleozoic pelecypod studies.

Meanwhile, in revising the Chemung stage species, I have briefly discussed the generic names used, but no generic revision was attempted. It cannot be too strongly stressed that such revision will undoubtedly lead to changes in many of the generic assignments.

The higher categories for Paleozoic pelecypods are equally confused, and, by using only informal categories for grouping the genera in the table of contents, I have hoped to avoid obscuring our present ignorance. I believe that the genera within each group are probably more closely related to each other than to genera in other groups but, as yet, this is largely subjective opinion, particularly regarding the "mytiloid" and "possibly edentulous" genera. Within each group the relations are even less certain, the only reasonably firm inference being that the three "nuculoid" (or "protobranchiate") genera represent separate but distantly related stocks which can conveniently be treated as families of a Subclass Protobranchiata (see Yonge, 1939, 1959; Cox, 1959).

REMARKS ON SYSTEMATICS

Preservation of the Fauna

All but a dozen or so of the Chemung stage specimens are preserved as "composite molds," which typically show superimposed features of both the interior and exterior of the original shell. The terminology and implications of this kind of preservation will be discussed in a separate paper (McAlester, in press). The few specimens which are not "composite molds" are preserved as internal molds, some of which preserve traces of much-flattened and recrystallized original shell material.

Doubtful Forms Not Included

Two species reported by Hall from possible Chemung stage localities have not been redescribed here. These are *Lunulicardium transversum* Hall (1885, p. 439, pl. 94, figs. 24, 25) from "Elmira, New York" and the four Elmira specimens of *Lunulicardium ornatum* (Hall) (1885, pl. 71, figs. 25-27, 31). The specimen on which *L. transversum* was based appears to be lost, but I have examined two of the *L. ornatum* specimens (figs. 26 and 27) and found that they occur in a calcareous mudrock matrix which is very atypical of Chemung stage lithologies. The specimens may have come from Finger Lakes stage horizons north of Elmira. Because my own collecting failed to turn up more specimens of the genus, it seems best to avoid redescription pending further discoveries.

My collections also contain three specimens of *Ontaria* (localities 75, 86, and 102) and one of *Buchiola* (locality 75) which are not described. I consider these genera to be doubtfully molluscan, although, to my knowledge, they have been universally treated as pelecypods. The restricted occurrence, unique ornamentation (in *Buchiola*), and common preservation as shiny, chitin-like films (especially *Ontaria*) makes me suspect that these are branchiopod crustaceans, but, in any event, the present material is too poor to warrant specific identification.

Laboratory Techniques

Nearly all specimens as found in the field were partially obscured by matrix. For removing this matrix, I found a small electric vibrator to be indispensable. The model used was the "Burgess Vibro-Graver" made by Burgess Vibrocrafters Inc., Grayslake, Ill. By using the vibrator under low-power binocular magnification (X10), it was possible to chip away most of the matrix without damaging the impression of the fossil.

In making casts of the negative composite molds, I found the latex compound "Permamold" made by the Polymer Chemical Co., Cincinnati 12, Ohio (see Baird, 1951) to be far superior to more widely distributed brands of molding latex. To reduce translucency, the dried latex casts were painted with black india ink.

Before being photographed, the specimens and latex casts were coated with magnesium oxide following the method outlined by Rasseti (1947). The photog-

raphy was done with a 4X5 camera and the individual figures were contact-printed at the final magnification. Kodak "Commercial" (blue-sensitive) film and Kodak "Azo F" paper were used.

Notes on the Descriptions

The following general comments will be useful in interpreting the scope and limitations of the systematic section.

Generic discussions. For most of the generic names, I have commented on the degree of certainty with which they are applied to the Chemung stage species, and for each genus, summaries are given of all previously described North American Upper Devonian species omitting only those which are redescribed or treated as synonyms in this report. For most of these species, I have also given my own preliminary and necessarily subjective evaluation as to their probable usefulness. This is not, however, a complete review of all North American Upper Devonian species because several large genera and many minor ones do not occur in the Chemung stage faunas. References are also given to the most valuable literature on each genus.

Synonymy. In the synonymy, citations are included for all references known to me to have original figures or descriptions of the species. Omitted are works such as faunal lists or stratigraphic discussions which contain only casual references to a species.

Probable synonyms for which insufficient evidence was available to permit definite synonymy are preceded by "[?]." Only the original reference is given for these names.

Revised descriptions. All descriptions were *based only on the Chemung stage specimens* available to me. In this way, I tried to eliminate subjectivity arising from inferences as to specific identity of Chemung and non-Chemung material. Future revisers may be confident that all features described here actually appear on the Chemung stage specimens deposited in the Yale Peabody Museum, unless I specifically indicate otherwise. Many of the rarer species will undoubtedly become better known through redescription of more abundant and well-preserved non-Chemung material.

In writing the descriptions, I have tried to use only a few universally understood morphologic terms. Exceptions to this are the preservational terms which I have proposed in a separate publication (McAlester, in press).

The descriptions generally follow this pattern: size, shape and shape variability, sculpture, dentition and hinge features, ligament, musculature and interior features, shell material. To prevent any possibility of misinterpretation, I have also indicated when any of these features are *not* describable from the Chemung material. An attempt has been made to support the description of unusual morphologic features with references to the illustrations in which they may be seen.

Complete measurements were made on all whole specimens, but these are not included in the descriptions except as averages or observed limits of variability. Graphs of measurements of all specimens are included for a few species where such data were found to be useful in supporting taxonomic conclusions. The complete measurements are deposited on open file at the Division of Invertebrate Paleontology, Peabody Museum, Yale University, New Haven, Connecticut, U.S.A.

Types. Holotypes are designated and refigured for all previously described

Chemung stages species, including definite synonyms, for which original material is available. In addition, holotypes are designated for some non-Chemung names where clear-cut choices were possible. I found no nomenclatural difficulties which required the designation of neotypes.

Material. This section gives the total number and present location of all specimens used in drawing up the descriptions. For most of the species, the descriptions are based only on the Yale Peabody Museum collections, and, for these species, the total number of specimens corresponds to the totals given in table 2. For a few species, additional information was obtained from specimens in the Hall collections of the American Museum of Natural History and the New York State Museum. Most of these specimens are refigured here and, in all cases, a note is included under "Material" when such specimens were used.

Throughout the systematic section (and in table 2), a single valve is considered to be one "specimen." For consistency, the less common occurrences of both valves in articulation are thus counted as two "specimens."

Occurrence. This section summarizes the known stratigraphic and geographic range of the species both within and outside of the Chemung stage. The comments on distribution within the stage are intended only to supplement the more detailed data in tables 1 and 2.

Comparisons. For new species, this section is a comparison with all closely related species of the genus. For previously described species, it is used only to indicate differences among the Chemung stage representatives of the genus.

Plates. All of the photographs are unretouched and some of the surrounding matrix, where present, is shown to eliminate subjective determination of obscure outlines. All figured specimens are composite molds unless otherwise noted.

In choosing specimens for illustration, it was necessary to show the entire range of morphologic variation, and, with limited space, this led to an unavoidable overemphasis on the less common extreme variants at the expense of the more abundant and typical forms. Where necessary, the plates have been supplemented by text figures which show graphically the total distribution of shape variants.

SYSTEMATIC PALEONTOLOGY

Genus PALAEONEILO[1]

Author. Hall and Whitfield, 1869, p. 6.

Type species. *Nuculites constricta* Conrad (1842, p. 249) by subsequent designation of Hall, 1885, p. xxvii.

Discussion. The genus name is used here provisionally for the inequilateral nuculoid species of the Chemung fauna which presumably differ from the true nuculids in the absence of a chondrophore. As in all other larger categories of early Paleozoic pelecypods, the numerous names for nuculoid genera are badly in need of restudy and revision. Such revision may show the genus *Palaeoneilo* to be a subjective synonym of *Ctenodonta* Salter as suggested by Beushausen (1895), but generic level differences in the type species of the two genera appear likely to me and thus *Palaeoneilo* will be retained for the present.

At least seven species of the genus, other than those discussed below, have been described from the Upper Devonian of the Northern Appalachian region, although the genus is apparently unreported elsewhere in the North American Upper Devonian. These species, along with comments as to their probable validity, are summarized below in alphabetical order:

P. arata Hall. Described by Hall (1885, p. 341) from the "Hamilton Group" [possibly Finger Lakes stage] near Norwich, Chenango County, New York. This is probably not a nuculoid pelecypod.

P. brevicula Clarke. Described by Clarke (1904, p. 313) from "the soft shales at forks of Cattaraugus Creek, Gowanda" [Cattaraugus County, New York], the locality probably representing a horizon low in the Cassadaga stage of the Upper Devonian. The species is based on a single poorly known specimen and cannot be recognized without further study.

P. crassa Clarke and Swartz. Originally described (Clarke and Swartz, 1913, p. 626) from the "Chemung" of Maryland. This species is illustrated by a single well-preserved internal mold and cannot be recognized without further knowledge of its external features.

P. elongata Hall. The species is based on an illustrated specimen (Hall, 1885, pl. 48, fig. 39) from the Cassadaga stage at Philipsburgh (now Belmont), Allegany County, New York, which appears to be too poorly preserved for generic or specific determination.

P. filosa (Conrad). The species was originally based on specimens from the Finger Lakes stage at Ithaca, Tompkins County, New York (Conrad, 1842, p. 250). This

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[1] The Invalid Emendation (Hemming, 1953, p. 43) *Palaeoneilo* of Hall and Whitfield, 1873 (p. 241), has been placed on the *Official List of Generic Names in Zoology* (Hemming and Noakes, 1958, p. 79) in preference to the Valid Original Spelling *Palaeaneilo* of Hall and Whitfield, 1869 (p. 6) in a controversial decision of the International Commission on Zoological Nomenclature [see Bulletin of Zoological Nomenclature, v. 1, pt. 8, June 1946, p. 192 and v. 4, pts. 13/15, June 1950, p. 399 and Opinions and Declarations, etc., v. 4, 1954, pt. 5, p. 51-62, Opinion 215. Note that the final opinion chooses to ignore Cooper's (1931) evidence of joint authorship and is also in error as to the manner of designation of the type species.] This action has been criticized in a note by Sinclair (1951, p. 411) with whom I am in complete agreement about the inadvisability of the decision. Presumably, the new emendation provisions of the Copenhagen Decisions (Hemming, 1953, p. 43) will prevent such occurrences in the future. The emended spelling as contained in the official list will be used here, following the recommendations of the Copenhagen Decisions (p. 45, paragraph 74).

species will probably prove to be valid and may even be a senior subjective synonym of various related Middle Devonian species of the *P. fecunda-P. tenuistriata* group (see Hall, 1885, p. 336-337 for descriptions and illustrations of the Middle Devonian forms).

P. linguata Clarke. This species is based on specimens from the Cassadaga stage at Forestville, Chautauqua County, New York (Clarke, 1904, p. 314). The species may prove valid but cannot be recognized without further study.

P. similis Whitfield. The species was based on material from the "Erie Shale" (probably Cassadaga or Conewango stage) of Lake County, Ohio (Whitfield, 1882b, p. 217). The only figured specimen is an internal mold (Whitfield, 1891, pl. 12, figs. 4-5) and the species cannot be adequately recognized without further knowledge of its exterior features.

In addition to the Upper Devonian species listed above, the Middle Devonian species *P. emarginata* and *P. plana* are cited by Hall (1885, p. 335, 339) from the Finger Lakes stage at Ithaca, New York. *P. plana* will probably prove to be a junior subjective synonym of *P. constricta* (Conrad) and therefore its report can be dismissed. *P. emarginata* is undoubtedly a valid species and Hall's figured specimen from Ithaca (1885, pl. 50, fig. 11) appears to be a typical specimen which may record an Upper Devonian occurrence of the species, although confirmation is needed.

Important discussions of Paleozoic nuculoid genera are given by Beushausen (1895), Hind (1896-1904), Williams and Breger (1916), Quenstedt (1930), Pfab (1934), Isberg (1934), Schenck (1934a, 1934b), Maillieux (1937), and La Rocque (1950).

Palaeoneilo constricta (Conrad)

(Plate 1, figures 1-18)

Nuculites constricta Conrad, 1842, p. 249, pl. 15, fig. 8.

Palaeaneilo constricta (Conrad). Hall and Whitfield, 1869, p. 7. Whitfield, 1882a, p. 335, pl. 26, figs. 13, 14.

Palaeoneilo constricta (Conrad). Hall, 1883, p. 14, pl. 48, figs. 1-20, pl. 51, fig. 17. Hall, 1884b, pl. 7, fig. 16. Hall, 1885, p. 333, pl. 48, figs. 1-20, pl. 51, fig. 17. Grabau, 1899, p. 256, fig. 173, Kindle, 1896, p. 42. Clarke, 1904, p. 311, pl. 15, figs. 9-13. Cleland, 1911, p. 102, pl. 20, figs. 9, 19-22. Prosser and Kindle, 1913, p. 235, pl. 26, figs. 9-12. Clarke and Swartz, 1913, p. 620, pl. 61, figs. 7-10.

Palaeoneilo cf. *constricta* (Conrad). Clarke, 1908, p. 233, pl. 24, fig. 6. Kindle, 1912, p. 87, pl. 7, fig. 10. Pohl, 1929, p. 34, pl. 4, figs. 2-15. Cooper and Cloud, 1938, p. 452, pl. 55, fig. 2.

Nucula bellatula Hall, 1843, p. 197, fig. 78, no. 7.

[?] *Nuculites maxima* Conrad, 1841, p. 50 [later references omitted, this is *Palaeoneilo maxima* (Conrad) of later authors, see especially Hall, 1885, p. 335].

[?] *Palaeaneilo plana* Hall and Whitfield, 1869, p. 7 [later references omitted, see especially Hall, 1885, p. 334].

[?] *Palaeaneilo brevis* Hall and Whitfield, 1869, p. 10 [later references omitted, see especially Hall, 1885, p. 342].

[?] *Palaeoneilo petila* Clarke, 1904, p. 311, pl. 15, figs. 1-8 [later references omitted].

Revised description based on specimens from Chemung stage. Shell of medium size (median length of 101 specimens 16 mm), equivalve, inequilateral, moderately inflated. Shape variable, height ranging from 41 to 86 percent of length. Margins variable, but ventral margin in all well-preserved specimens shows slight re-entrant near posterior extremity, this re-entrant corresponding to a faint radial groove on the surface of the valve. Umbones anterior to center of valve, directed forward, small, extending slightly above dorsal margin. Surface sculpture of fine, regularly spaced concentric ridges present on well-preserved, predominantly external composite molds (pl. 1, figs. 4, 11, 15); wider, irregularly spaced concentric furrows and ridges present on some composite molds (pl. 1, figs. 1, 6, 17). Most composite molds are dominated by interior and are smooth (pl. 1, figs. 2, 8, 18). Lunule and escutcheon unknown. Dentition present on

many composite molds as impressions of hinge plate in front of and behind umbones (pl. 1, figs. 4, 11, 13). Impressions show teeth to have been numerous, small, extending along entire dorsal margin and elongated at right angles to margin (pl. 1, fig. 9). Dentition of central part of hinge plate unknown, obscured by umbone in all specimens. Ligament unknown. Anterior and posterior muscle scars present as faint impressions on several composite molds (pl. 1, figs. 4, 10, 11, 12), other interior features unknown. Shell material unknown.

Types. Holotype of *Palaeoneilo constricta* (Conrad), here designated, the specimen shown by Conrad, 1842, as fig. 8 of pl. 15, whereabouts unknown. Type locality: near Moravia, Cayuga County, New York, U.S.A. Stratigraphic position: Hamilton Group, Middle Devonian. Conrad's types are probably lost but may be as yet undiscovered among the various Hall collections scattered at several museums. Because the species is the type of the genus *Palaeoneilo,* it will probably be desirable to designate a neotype in future generic revision, although Conrad's illustration is clear enough to show that the species has been correctly interpreted by later authors.

Material. The revised description was based on 170 specimens from the Chemung stage, all of which are permanently deposited in the Yale Peabody Museum.

Occurrence. This widespread Middle Devonian species is one of the most common pelecypods of the Chemung stage. It was found at 24 localities representing all generalized stratigraphic horizons within the stage. It was most abundant at localities 30, 34, and 38, all of which represent horizons low in the stage. No differentiation could be made between specimens from these localities and those from the highest beds of the stage.

Elsewhere in the Upper Devonian the species is reported by Hall (1885, p. 333, 334) from Ithaca (Finger Lakes stage) and will probably prove to be abundant throughout the pre-Chemung Upper Devonian of the Appalachian region. Post-Chemung occurrences are also probable and may be represented by the Chautauqua County specimens reported by Hall (1885, p. 333, pl. 51, fig. 17) and Clarke (1904, p. 311, pl. 15, figs. 9-13). The species will likely prove to be even more widespread in the Upper Devonian as analyses of variation are made in species which are presumed to be distinguishable from *P. constricta.*

Comparisons. Within the Chemung stage the species is easily recognized by its distinctive shape, single marginal re-entrant, and single posterior radial groove. These two last features readily distinguish it from *P. bisulcata* and *P. angusta,* both of which have double posterior re-entrants and radial grooves.

Discussion. The Upper Devonian forms described here almost certainly belong to the same species as the Middle Devonian forms now known as *Palaeoneilo constricta* (Conrad). The great shape variability of the Chemung specimens is shown in pl. 1. This same degree of variability is also shown in all Middle Devonian samples that I have examined in the Yale Peabody Museum, the only difference in the Middle and Upper Devonian forms being a consistent preservation of fine, regular, surface sculpture in the Middle Devonian specimens. This difference is almost certainly a result of the preservation. The Chemung specimens commonly occur in a silty matrix unfavorable to the preservation of surface sculpture in composite molds, whereas the Middle Devonian forms typically occur in a much finer shale matrix where such sculpture is readily preserved. A few Chemung stage specimens clearly show the fine concentric sculpture characteristic of the Middle Devonian forms (pl. 1, figs. 4, 11) and these all occur in a shale matrix at localities where more poorly preserved specimens are found in siltier layers *interbedded with the shales.* These occurrences confirm the fact that the difference in sculpture is caused by preservation.

The variability and preservational peculiarities in this genus make it likely that the five species listed above as questionable synonyms will prove indistinguishable from the Middle Devonian *P. constricta* on future analysis of variability based on large collections. Pending such studies, no more definite synonymy will be given here.

A major nomenclatural problem revolves around the status of the questioned synonym *Palaeoneilo maxima* (Conrad, 1841). Should this species prove to be identical with *P.*

constricta (Conrad, 1842), a most likely prospect, in my opinion, then the name *P. maxima,* being earlier, must replace *P. constricta* for the common Middle Devonian species. In itself this would not lead to unmanageable confusion, except that in the original description of *"Nuculites" maxima,* Conrad gives no figure and lists as the only locality, "Oneonta, New York," an area now known to expose only Upper Devonian rocks. The first illustrations and adequate descriptions of the species were given by Hall (1885) who, possibly with Conrad's approval or advice (see Hall's preface, 1884c, p. viii), did not record the species as coming from Oneonta, the only localities cited being "Summit and Fultonham, Schoharie County" (now known to be at or near the Middle-Upper Devonian boundary) and "on the shores of Cayuga Lake" (Middle Devonian). Clearly then, the species cannot be understood until a restudy is made of the Upper Devonian occurrences in the Oneonta region.

The problem is still further complicated because Hall designated *P. constricta* as the type of genus *Palaeoneilo.* Based on this species, the holotype of which is Middle Devonian, the genus can be adequately understood because specimens are plentiful and well-preserved in the area of the type locality. Should *P. maxima* be the correct name for the species, the genus will be based ultimately on Upper Devonian type material from Oneonta, an area where preservation will probably be very poor. Thus the genus *Palaeoneilo* stands to lose in the clarity of its definition should further study confirm the suggested synonymy and a suspension of rules may become desirable in future generic revision.

Palaeoneilo bisulcata Hall and Whitfield

(Plate 2, figures 1-10)

Palaeaneilo bisulcata Hall and Whitfield, 1869, p. 10.
Palaeoneilo bisulcata Hall [and Whitfield]. Hall, 1883, p. 14, pl. 50, figs. [12], 13, 14. Hall 1884b, pl. 7, fig. 21. Hall, 1885, p. 344, pl. 50, figs. 12-14.
Palaeoneilo filosa (Conrad). [?] Clarke and Swartz, 1913, p. 623, pl. 61, figs. 11, 12.
[?] *Palaeoneilo muricata* Clarke, 1904, p. 312, pl. 15, figs. 14, 15 [later references omitted].

Revised description based on specimens from Chemung stage. Shell of medium size (median length of 16 specimens 14 mm), equivalve, inequilateral, moderately inflated. Shape variable, height ranging from 50 to 67 percent of length. Posterior margin with two concave re-entrants corresponding to two radial grooves on posterior surface of valves. Umbones anterior in position, directed forward, small, extending slightly above dorsal margin. Prominent surface sculpture of fine, regularly spaced concentric ridges present on all composite molds; number of ridges variable (pl. 2, figs. 5, 6, 8). Lunule and escutcheon unknown. Obscure impression of taxodont dentition present on several composite molds (pl. 2, figs. 2, 4). Ligament unknown. Musculature and interior features unknown. Shell material unknown.

Types. Holotype of *Palaeoneilo bisulcata* Hall and Whitfield, here designated, the specimen shown by Hall, 1885, as fig. 14 of pl. 50, No. 2918 in the New York State Museum, Albany, New York, U.S.A. (pl. 2, figs. 1, 2). Type locality: near Elmira, New York, U.S.A. Stratigraphic position: Upper Devonian, Chemung stage.

Material. The revised description was based on 29 specimens from the Chemung stage, all of which are permanently deposited in the Yale Peabody Museum.

Occurrence. This distinctive species is known with certainty only from the Chemung stage in New York and northern Pennsylvania. Within the stage it was found at ten localities representing all generalized stratigraphic horizons. Although the species occurs throughout the geographic and stratigraphic extent of the stage, it is nowhere common and is represented, at most, by only a few specimens at a single locality. No differentiation could be made between specimens from the lowest and highest horizons of the stage.

Comparisons. This species and the next one, *P. angusta,* appear to be the only species of *Palaeoneilo* from the North American Upper Devonian which have the distinctive double re-entrants of the posterior margin and consequently they are unlikely to be mis-

identified. The species is distinguishable from *P. angusta* in being less elongate (form ratio of 50 to 67 percent in known specimens, see fig. 2) and in having more prominent concentric sculpture.

Discussion. Hall's collections apparently contained only a few of these distinctive doubly grooved specimens of *Palaeoneilo*. In the original description of *P. bisulcata* (Hall and Whitfield, 1869, p. 11), the authors stated: "This is a rather rare species, only two individuals having been obtained among a large collection of other fossils." The locality was given as "near Elmira, N. Y." and the specimens probably came from the now lost locality of "Buck's Quarry" (see Whitfield and Hovey, 1899, p. 295). In the final publication of 1885, Hall gave figures of three specimens and dimensions of a fourth, all from "near Elmira." In 1885 he also described a more elongate but closely related species, *P. angusta* from "near Elmira," for which he gave a single figure and dimensions of two specimens. I have found only these figured specimens in the Hall collections at the American Museum of Natural History and the New York State Museum. It thus

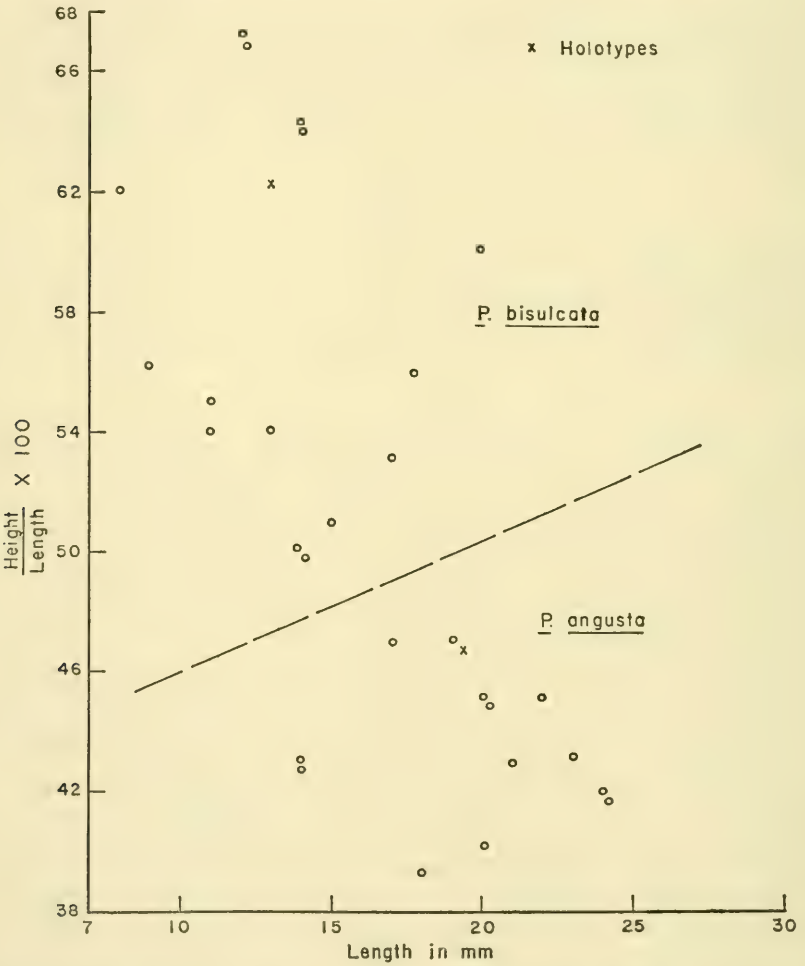

Figure 2. *Palaeoneilo bisulcata* and *Palaeoneilo angusta*. Scatter diagram of length X form ratio (height expressed as percentage of length), showing size and shape distribution of all measurable Chemung stage specimens.

appears that the two species were founded on about four specimens, all from the Elmira region. My own collections for the present study contain 48 specimens of these doubly grooved forms from 14 localities, and an analysis of their morphology and occurrence confirms the validity of Hall's two species (see fig. 2).

The two species are commonly found together in the middle and upper beds of the stage (localities 22, 66, 87, 102). It is significant that the youngest beds of the stage (localities 86, 87) contain the most extreme differences in form ratio in the two species, whereas the lower occurrences (especially locality 102) show form ratios near 50 percent for both species (see fig. 2). This may be an example of speciation within the Chemung stage, *P. bisulcata* giving rise to *P. angusta* in early Chemung time. Neither species is now known outside the Chemung stage.

Palaeoneilo angusta Hall

(Plate 2, figures 11-16)

Palaeoneilo angusta Hall, 1885, p. 344, pl. 93, fig. 11. [?] Clarke and Swartz, 1913, p. 624, pl. 61, fig. 13. [?] Willard, 1939, p. 26, fig. 24.

Revised description based on specimens from Chemung stage. Shell of medium size (median length of 14 specimens 20 mm), equivalve, inequilateral, moderately inflated. Shape variable, height ranging from 39 to 47 percent of length (fig. 2). Posterior margin with two concave re-entrants corresponding to two radial grooves on posterior surface of valves. Umbones anterior in position, directed forward, small, extending slightly above dorsal margin. Surface sculpture of fine, regularly spaced concentric ridges preserved on posterior radial grooves of all composite molds, becoming indistinct anteriorly, possibly reflecting less prominent sculpture on anterior part of original shell. Irregularly spaced concentric furrows are present anterior to radial grooves in most composite molds. Lunule and escutcheon unknown. Obscure impression of taxodont dentition present on several composite molds (pl. 2, figs. 12, 14). Ligament unknown. Musculature and interior features unknown. Shell material unknown.

Types. Holotype of *Palaeoneilo angusta* Hall, here designated, the specimen shown by Hall, 1885, as fig. 11 of pl. 93, No. 2915 in the New York State Museum, Albany, New York, U.S.A. (pl. 2, figs. 11, 12). Type locality: near Elmira, New York, U.S.A. Stratigraphic position: Upper Devonian, Chemung stage.

Material. The revised description was based on 19 specimens from the Chemung stage, all of which are permanently deposited in the Yale Peabody Museum.

Occurrence. The species is known only from the Chemung stage in New York and northern Pennsylvania. Within the stage it was found at eight localities representing all generalized stratigraphic horizons. The species is uncommon, being represented by only a few specimens at each locality.

Comparisons. See *P. bisulcata.*

Discussion. See *P. bisulcata.*

Genus NUCULOIDEA

Author. Williams and Breger, 1916, p. 173.

Type species. *Cucullea opima* Hall (1843, p. 197 = *Nucula randalli* Hall of later authors) by original designation.

Discussion. Following the suggestion of La Rocque (1950, p. 300), Williams and Breger's subgenus *Nuculoidea* will be used here for the Devonian species of "*Nucula.*" To my knowledge, no clear generic-level distinction has yet been made between the recent genus *Nucula* Lamarck and the many similar chondrophore-bearing Paleozoic shells formerly assigned to this genus. Williams and Breger (1916, p. 173) thought that the "persistent absence of the denticulate ventral margin in the early and frequently large *Nuculas* and its persistent development in the recent *Nuculas* furnish a ready and easy distinction."

Specimens of *N. opima*, the type of Williams and Breger's *Nuculoidea*, in the Yale Peabody Museum, clearly show fine radial ridges on the inner ventral margin and this feature therefore lacks value as a generic character, as has been noted by Vokes (1949). Later attempts at differentiation need evaluation in the light of a complete restudy of all proposed genera of Paleozoic nuculoid pelecypods. Pending such revision, Williams and Breger's name is used here in the hope that *N. opima* (Hall) will prove generically distinguishable from the many nuculoid genera based on post-Paleozoic type species.

Four species of "*Nucula*," in addition to those treated below, have been described from the North American Upper Devonian. I consider all of these species to be too poorly known for *generic* identification. They are:

N. diffidens Hall, 1883, p. 14. Described from the Finger Lakes stage at Ithaca, New York. Apparently based only on internal molds.

N. globularis Hall, 1885, p. 322. Described from the Conewango stage (?) at Panama, New York. Apparently known from a single poorly preserved specimen.

N. rescuensis Walcott, 1884, p. 172. Described from "Middle to Upper Devonian horizon; Rescue Hill, west of Rescue Cañon, Eureka District, Nevada." Apparently known only from a single specimen.

N. snyderensis Branson, 1922, p. 112. Described from the Snyder Creek shale (Finger Lakes stage?) at "Cow Creek, Calloway County, Missouri." Apparently known only from internal molds.

In addition to these species based on Upper Devonian material, two Middle Devonian species, other than *N. corbuliformis* which is described below, have been illustrated from the North American Upper Devonian. Hall (1885, pl. 45, fig. 13) showed a specimen of "*Nucula*" *lamellata* from Ithaca which cannot be recognized as this Middle Devonian species from his figure. The other report is of *N. lirata* (Conrad) which was illustrated by Branson (1922, pl. 25, figs. 17-18) from the Upper Devonian Snyder Creek shale of Missouri. I consider the illustrated specimen to be of doubtful generic affinities, the specific identification having been questioned by Branson himself who remarked (1922, p. 112), "the identification is uncertain at the best."

Nuculoidea corbuliformis (Hall and Whitfield)

(Plate 3, figures 1-20)

Nucula corbuliformis Hall [and Whitfield], 1869, p. 2. Hall, 1883, p. 13, pl. 46, figs. 24-37. Hall, 1885, p. 319, pl. 46, figs. 24-34 (10, 11, 35-37?). Grabau, 1899, p. 253, fig. 169A. Kindle, 1900, p. 677, pl. 14, fig. 5. Prosser and Kindle, 1913, p. 226, pl. 23, figs. 6-10. Clarke and Swartz, 1913, p. 619, pl. 60, figs. 19-23. [?] Willard, 1939, pl. 26, fig. 8.

Nucula cf. *corbuliformis* Hall [and Whitfield]. Kindle, 1912, p. 88, pl. 7, fig. 15.

[?] *Nucula subtrigona* Simpson, 1890, p. 452, 3 figs. [later references omitted].

Revised description based on specimens from Chemung stage. Shell of small size (median length of 35 specimens 8 mm), equivalve, equilateral to inequilateral, moderately inflated. Shape variable. Umbone central or posterior[1] in position, directed backward, inflated, extending above dorsal margin. Surface sculpture of fine, regularly spaced, concentric ridges present on well-preserved composite molds (pl. 3, figs. 7, 12, 15). Lunule and escutcheon unknown. Dentition obscurely represented on single composite mold which shows impression of posterior teeth (pl. 3, fig. 18). Other hinge features unknown. Ligament unknown. Pallial line possibly represented in many composite molds as prominent concentric furrow parallel to ventral margin (pl. 3, figs. 2, 4, 7, 11, 13, 15); if so, pallial line non-sinuated. Other interior features unknown. Shell material unknown.

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[1] The end nearest the umbones of inequilateral valves is arbitrarily used here as "posterior" by analogy with living nuculids. The actual orientation of the living soft parts is unknown.

TYPES. No holotype will be designated pending restudy of the many Middle Devonian specimens figured by Hall.

MATERIAL. The revised description was based on 89 specimens from the Chemung stage, all of which are permanently deposited in the Yale Peabody Museum.

OCCURRENCE. This rather widespread Middle Devonian species is known with certainty in the Upper Devonian only from the Chemung stage of New York and northern Pennsylvania. Hall's questioned illustration of a specimen from Ithaca (Hall, 1885, pl. 46, fig. 37) probably represents a Finger Lakes stage occurrence. The species apparently also occurs in the Upper Devonian (Finger Lakes and Chemung stages?) of Maryland (Clarke and Swartz, 1913, p. 619). More detailed collecting will almost certainly show the species to be common in the pre-Chemung Upper Devonian of the northern Appalachian region. It may be absent from the post-Chemung, however, because only one specimen was found in the highest horizons of the Chemung stage.

Within the Chemung stage, the species was found at 13 localities representing all but the highest generalized stratigraphic horizons. No differentiation could be made between specimens from the lower and higher occurrences. The species was abundant only at localities 23B, 38, and 102.

COMPARISONS. The species is the only representative of the genus in the Chemung stage and is unlikely to be misidentified.

DISCUSSION. Comparison of the Chemung specimens described here with Middle Devonian specimens of *N. corbuliformis* in the collections of the Yale Peabody Museum showed the two to be indistinguishable and consequently the name of the Middle Devonian species is applied here without reservation to the Chemung specimens.

GENUS "NUCULANA"

AUTHOR. Link, 1807, p. 155.

TYPE SPECIES. *Arca rostrata* Chemnitz, (1784, p. 206) by monotypy.

DISCUSSION. The Paleozoic nuculanid pelecypods have generally been assigned to the recent genus *Nuculana* Link (= *Leda* Schumacher, for discussion see Fletcher, 1945, p. 302) on the basis of general similarity in shell shape and dentition. For nomenclatural convenience, however, I believe that names of living genera should be used for Paleozoic pelecypods only where generic identity can be conclusively proved by large numbers of specimens preserving the details of shell form and structure. I know of no case where such generic identity has been unquestionably established between Devonian and living pelecypods because this kind of proof is all but impossible in the pre-Carboniferous forms where the shell material is so rarely preserved.

A further complication arises in the use of the name *Nuculana* because most of the well-preserved Carboniferous specimens assigned to the genus do not have a pallial sinus and therefore lack the siphons which are so characteristic of living nuculanids (see Hind, 1897, p. 193, and Williams and Breger, 1916, p. 171). Probably, most of the Paleozoic species represent transitional stages between the nuculids and the nuculanids (see Yonge, 1939).

Recently, Chernyshev (1951, not seen, fide Elias, 1957, p. 749) has proposed two new generic names for Carboniferous nuculanids, but to my knowledge no name has yet been proposed for the typical Devonian forms. Although future work may show Chernyshev's names to be useful for Devonian species, pending a complete revision of all Paleozoic nuculanids the recent generic name *Nuculana* will be used here with quotation marks to indicate that it is being used in a broad and probably incorrect sense.

This is apparently the first documented report of the genus from the New York Upper Devonian, although it has frequently been mentioned in faunal lists. The only other record of the genus from the North American Upper Devonian appears to be that of Clarke and Swartz (1913, p. 626) who reported *Leda* cf. *diversa* from the "Chemung" of Maryland. The specimens figured by these authors are internal molds and the species in question cannot be recognized without further study.

"Nuculana" rostellata? (Conrad)

(Plate 2, figures 17-20)

Nuculites rostellata Conrad, 1841, p. 50.
Leda? *rostellata* (Conrad). Hall and Whitfield, 1869, p. 5.
Leda (Nuculana) rostellata (Conrad). Hall, 1883, p. 13, pl. 47, figs. 45-47.
Leda rostellata (Conrad). Hall, 1885, p. 330, pl. 47, figs. 42-47. Prosser and Kindle, 1913, p. 247, pl. 28, figs. 5-7. [?] Willard, 1939, pl. 26, fig. 21.
Leda (*Nuculana*) *perstriata* Hall, 1883, p. 13, pl. 47, figs. 42-44.

Revised description based on specimens from Chemung stage. Shell of small size (median length of 9 specimens 5 mm), equivalve, inequilateral, moderately inflated. Shape variable. Umbone small, anterior or sub-central in position. Prominent surface sculpture of very fine, evenly spaced concentric ridges preserved on most composite molds, the larger specimens having from 12 to 15 ridges per mm measured normal to the ventral margin below the umbo. Lunule and escutcheon unknown. Dentition and hinge features unknown. Ligament unknown. Musculature and interior features unknown. Shell material unknown.

Types. Conrad's original description was published without illustration and his types are probably lost, the species being known only from Hall's later figured specimens, none of which come from the original type locality.

Material. The revised description was based on ten specimens from the Chemung stage, all of which are permanently deposited in the Yale Peabody Museum.

Occurrence. Apparently this is the first report of this rare Middle Devonian species from the Upper Devonian. Within the Chemung stage the species was found only at locality 102 where it is common.

Comparisons. See *"Nuculana"* sp.

Discussion. An examination of about 50 specimens of New York Middle Devonian *"Nuculana"* in the collections at the Yale Peabody Museum showed two groups to be present; a common, coarsely sculptured (5 to 8 ridges per mm), inflated form which is probably Hall's *Leda diversa*, and a rare form with much finer sculpture (11 to 28 ridges per mm), a less inflated shell, and, in some specimens, an extremely elongate posterior. The Chemung species closely resembles the less elongate specimens of the second group, but too few of the Middle Devonian forms were available to allow me to determine the limits of variability in the "species." On the basis of the present evidence, I feel that the Chemung specimens are most likely conspecific with a New York Middle Devonian species whose correct name and limits of morphologic variation are doubtful, but which is probably represented by at least some of the specimens figured by Hall (1885) as *Leda rostellata* (Conrad). For these reasons the name *rostellata* is applied with a question mark to the Chemung species, pending revision of the Middle Devonian forms.

"Nuculana" sp.

(Plate 2, figure 21)

Two poorly preserved specimens of this genus were found in coquinite layers at locality 28. They differ from the locality 102 specimens of *"Nuculana" rostellata*? in being larger and having much coarser concentric sculpture. These specimens probably represent a different species of the genus, but the material is too poor to justify a new name.

Genus GRAMMATODON

Subgenus COSMETODON

Author of genus. Meek and Hayden, 1860, p. 419.

Author of subgenus. Branson, 1942, p. 248.

Type species of subgenus. *Arca keyserlingii* d'Orbigny (1850, p. 369) by original designation.

Discussion. This distinctive genus (and subgenus) are apparently known in the North American Upper Devonian only from the single species described below.

This genus and related genera have been thoroughly reviewed by Arkell (1930) who concluded that the Paleozoic and Mesozoic species previously assigned to the genera *Macrodon, Parallelodon, Grammatodon,* and *Beushausenia* were congeneric, a conclusion that is tentatively accepted here. Arkell's nomenclature was, however, grossly incorrect and a clear nomenclatural correction was subsequently published by Branson (1942) whose conclusions are accepted here.

Grammatodon (*Cosmetodon*) *chemungensis* (Hall and Whitfield)

(Plate 4, figures 1-20)

Macrodon chemungensis Hall and Whitfield, 1869, p. 14.
Macrodon chemungensis Hall [and Whitfield]. Hall, 1883, p. 14, pl. 51, figs. 11-16. Hall, 1884a, pl. 8, figs. 5, 6. Hall, 1885, p. 350, pl. 51, figs. 11-16. Clarke and Swartz, 1913, p. 627, pl. 61, fig. 18.

Revised description based on specimens from Chemung stage. Shell of medium size (median length of 48 specimens 19 mm), equivalve, inequilateral, elongate, moderately inflated. Shape variable. Ventral margin slightly indented near mid-length by faint radial depression. Umbones directed forward, small, extending to or slightly above dorsal margin. Umbones anterior in position, distance from umbone to anterior extremity usually less than ¼ of shell length. Surface sculpture of fine, widely spaced concentric ridges present in predominantly external composite molds (pl. 4, fig. 9). Most composite molds show coarse, irregularly spaced concentric furrows (pl. 4, figs. 5, 8, 10). Radial ornamentation apparently absent. Lunule and escutcheon unknown. Two or three fine posterior hinge teeth represented on many composite molds as groove-like impressions along posterior dorsal margin. Posterior teeth parallel to dorsal margin, ending just short of posterior margin, the small space between margin and teeth being occupied by extensions of concentric sculpture (pl. 4, fig. 16). Cardinal teeth unknown in Chemung stage specimens. A single Cassadaga stage specimen figured by Hall shows impression of typical parallelodont cardinal dentition (pl. 4, fig. 17). Musculature and interior features unknown. Shell material unknown.

Types. Holotype, here designated, the specimen shown by Hall, 1885, as fig. 14 of pl. 51, No. 6132/1:1 in the American Museum of Natural History, New York, New York, U.S.A. (pl. 4, figs. 1, 2). Type locality: Buck's Quarry [?], near Elmira, New York, U.S.A. Stratigraphic position: Upper Devonian, Chemung stage.

Material. The revised description was based on 71 specimens from the Chemung stage, all of which are permanently deposited in the collections of the Yale Peabody Museum. A Cassadaga stage specimen from the Hall collections of the New York State Museum is figured to show the cardinal dentition of the species (pl. 4, fig. 17).

Occurrence. The species is known only from the Upper Devonian of New York and northern Pennsylvania. It is apparently most common in the Chemung stage, occurrences in later stages probably being represented by Hall's (1885, p. 351) report of specimens from Allegany and Cattaraugus Counties, New York and from Crawford County, Pennsylvania. No pre-Chemung occurrences are known to me.

Within the Chemung stage the species was common only at locality 75. It was rare or occasional at localities 86, 87, 22, 23B, and 60. It was not found in the lower horizons of the stage. Most of Hall's Chemung stage specimens appear to have come from the enigmatic "Buck's Quarry, near Elmira," the exact location of which is now unknown. His report of specimens from "Chemung Creek" may represent other occurrences at Narrow Hill (locality 22 of this report).

Comparisons. This distinctive species is unlikely to be confused with other Chemung stage pelecypods.

Genus ACTINOPTERIA

Author. Hall, 1884c, p. xxi.[1]

Type species. *Avicula decussata* Hall (1843, p. 203) by subsequent designation of Bassler, 1915, p. 16.

Discussion. In attempting to give meaningful generic names to the seven species of Chemung stage pterioids, I made a brief review of the literature and found that Devonian pterioid pelecypods have been assigned to at least 35 different genera and subgenera, most of which are based on Devonian type species. This survey was undoubtedly incomplete and did not take into account the many Paleozoic pterioid genera which have never been reported from the Devonian. For each of these genera an attempt was made to tabulate the important characters of the type species as shown by illustrated specimens. Such features as convexity of valves, nature of hinge and auricles, and type of ligament and dentition were recorded, because these features have been commonly used to differentiate pterioid genera. The result showed more than the usual generic chaos. The dentition of nearly all the type species is too poorly known to serve as a generic character. In all of the genera in which the ligament is known, it is of the external chevron-groove type. Nearly all of the genera have a right valve which is somewhat less convex than the left. This means that most of the genera are defined by surface sculpture and subtle differences in shape. In my opinion, many of these differences are only of specific value. I doubt that more than a quarter of the proposed generic names will eventually prove useful, and even some of these will probably prove to be synonyms of other Paleozoic genera which are as yet unreported from the Devonian.

Meanwhile, an explicit generic assignment of the Chemung pterioids is impossible. Pending complete generic revision, the following assignments will be adopted because of similarity of the Chemung specimens to the generic type species. It cannot be stressed too strongly that these generic assignments are tentative and subject to change.

1. The name *Actinopteria* Hall is used for the reticulately sculptured Chemung pterioids.
2. The names *Leiopteria* Hall and *Leptodesma* Hall are used for the Chemung pterioids which lack strong radial sculpture. The Chemung species to which these names are applied are very similar to the type species of these genera which differ only in obliquity and shape of the anterior auricle.
3. The name *Cornellites* Williams is used tentatively for the large radially sculptured Chemung pterioids which were formerly assigned to the genus *Pterinea* Goldfuss (see also the discussion under *Cornellites*).

Actinopteria is rare in the North American Upper Devonian, although it is relatively abundant and widespread throughout the Lower and Middle Devonian of the Appalachian region. Four North American Upper Devonian occurrences, in addition to those described here, are reported in the literature.
These are:

1. The specimens from Ithaca, New York, described by Hall (1884c, p. 118-128) under the names *Actinopteria perstrialis, tenuistriata, delta, epsilon, zeta, eta, theta, iota,* and *kappa.* Restudy will probably prove most or all of these names to be synonyms because the differences in form and sculpture of Hall's figured specimens are almost certainly related to differences in quality of preservation in the composite molds. The species in question does, however, appear to differ from all species of

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[1] The genus "*Actinoptera*" was proposed by Hall in 1883 (p. 3) but this spelling was a junior homonym of the insect genus *Actinoptera* Rondani, 1871, a fact apparently noted by Hall, because in the final report of 1884 the spelling was emended to "*Actinopteria.*" The genus should thus be cited as *Actinopteria* Hall, 1884, this name being a junior objective synonym (by "invalid emendation") of *Actinoptera* Hall, 1883, which must be rejected as a junior homonym of *Actinoptera* Rondani, 1871.

Actinopteria known from the New York Middle Devonian (see also the discussion below of *Actinopteria* sp. A).

2. A single Chemung stage specimen from Lawrenceville, Tioga County, Pennsylvania, described by Hall (1884c, p. 121) as *Actinopteria auriculata*. This is probably an immature specimen which may be conspecific with the specimens described below as *Actinopteria* sp. B, the only *Actinopteria* that I found in the Lawrenceville area. In any event, the species cannot be recognized without more specimens, which I feel are unlikely to be found.

3. A single specimen from the Finger Lakes stage of Livingston County, New York, described by Clarke (1904, p. 263) as *Actinopteria sola*. This form is probably conspecific with Hall's Ithaca specimens.

4. The Conewango stage specimens described by Caster (1930, p. 64, 65) as *Actinopteria alpha* and *A. beta*. On the basis of the figures, these specimens cannot be certainly recognized as *Actinopteria* and acceptance of the species names must await restudy.

It appears, then, that the only specimens of the genus from the North American Upper Devonian are found in the northern Appalachian region. In this area the genus is common in the Finger Lakes stage, rare in the Chemung stage and not known with certainty from the post-Chemung Upper Devonian.

Useful discussions of Devonian pterioid genera are given by Follmann (1885), Frech (1891), Williams (1908), Clarke (1909), Maillieux (1913, 1919, 1929, 1932, 1937), Spriestersbach (1909, 1915) [not seen], Ruzicka (1949, 1950), La Rocque (1950), Elias (1957), and Ruzicka and Prantl (1957).

Actinopteria boydi (Conrad)[1]

(Plate 3, figures 25, 26)

Avicula boydii Conrad, 1842, p. 237, pl. 12, fig. 4.
Pterinea boydi (Conrad). Miller, 1877, p. 201.
Actinopteria boydi (Conrad). Hall, 1883, p. 8, 10, pl. 19, figs. 2-24, 26-30, [not] pl. 23, figs. 5, 6. Hall, 1884a, pl. 3, figs. 10, 11. Hall, 1884b, p. 301, pl. 3, figs. 10, 11. Hall, 1884c, p. 113, pl. 19, figs. 2-24, 26-30, pl. 84, figs. 16, 17. Walcott, 1884, p. 166, pl. 5, fig. 2. [?] Tschernyschew, 1887, p. 44, pl. 6, figs. 18-20. Nettelroth, 1889, p. 229, pl. 3, fig. 2. [?] Kindle, 1900, p. 667, pl. 13, fig. 2. [?] Cleland, 1911, p. 109, pl. 22, figs. 7, 8. Prosser and Kindle, 1913, p. 259, pl. 30, figs. 9, 10. [?] Clarke and Swartz, 1913, p. 642, pl. 64, fig. 2. Willard, 1939, pl. 24, fig. 2.
Actinopterella boydi (Conrad). Williams and Breger, 1916, p. 184.
Avicula perobliqua Conrad, 1842, p. 235, pl. 12, fig. 1.
Avicula quadrula Conrad, 1842, p. 243, pl. 13, fig. 5.
[?] *Actinopteria* aff. *boydi* Hall [Conrad?]. Nalivkin, 1934, p. 6, pl. 1, fig. 20.
[?] *Avicula angustirostra* Conrad, 1842, p. 236.
[?] *Avicula pleuroptera* Conrad, 1842, p. 242, pl. 13, fig. 2.
[?] *Avicula decussata* Hall, 1843, p. 203, figs. 1, 2 [later references omitted; this is *Actinopteria decussata* of Hall (1884c) and later authors].
[?] *Actinopteria subdecussata* Hall, 1883, p. 8, pl. 17, figs. 23, 25-27, 29-31, pl. 19, fig. 25 [later references omitted].

Revised description based on specimens from Chemung stage. Shell of medium size (median length of 5 specimens 21 mm), inequilateral, moderately inflated. Left valve convex, right valve unknown. Shape variable. Left valve shows rounded anterior auricle and slightly extended posterior wing. Hinge length equal to or exceeding greatest length of valve. Well-preserved composite molds show reticulate surface sculpture made up of prominent radial ridges and more obscure concentric ridges. Dentition and hinge features

[1] The original spelling *"boydii"* has been universally changed to *"boydi"* by later authors, and this change will be adopted here as the variant endings have no nomenclatural significance, the singular being preferred (see Hemming, 1953, p. 54).

unknown. Ligament unknown. Musculature and interior features unknown. Shell material unknown.

Types. Holotype of *Actinopteria boydi* (Conrad), here designated, the specimen shown by Conrad, 1842, as fig. 4 of pl. 12, whereabouts unknown. Type locality: Hamilton, Madison County, New York, U.S.A. Stratigraphic position: probably Middle Devonian.

Material. The revised description was based on ten specimens from the Chemung stage, all of which are permanently deposited in the Yale Peabody Museum.

Occurrence. This common Middle Devonian species is very rare in the North American Upper Devonian. It is known only from the Chemung specimens described here and also possibly from a single fragmentary specimen from the Upper Devonian Woodmont formation (Finger Lakes stage?) of Maryland figured by Clarke and Swartz (1913, pl. 64, fig. 2). Future collecting will probably show the species to be present, but rare, in the pre-Chemung Upper Devonian of New York. The Schoharie County specimens figured by Hall (1884c, pl. 19) may represent such occurrences low in the Upper Devonian.

Within the Chemung stage the species was found only in the middle horizons. It was occasional at locality 66 and was represented by single fragmentary specimens from localities 23B, 104, and 105.

Comparisons. See *Actinopteria* sp. A and sp. B.

Discussion. The few Chemung specimens described here were compared with large suites of New York Middle Devonian *Actinopteria* in the collections of the Yale Peabody Museum and were found to be indistinguishable from the common Middle Devonian species *Actinopteria boydi* (Conrad).

The nomenclature of the species *A. boydi* is rather complicated and requires some comment. In his 1842 report, Conrad described and figured four Devonian species which would now be assigned to the genus *Actinopteria*. These were *"Avicula" perobliqua, boydii, quadrula,* and *pleuroptera*. In Hall's final report (1884c, p. 113), all of these names were treated as subjective synonyms (two of them were merely cited as "compare"), and *A. boydii* was chosen as the name of the combined species. This synonymy may even have been made with Conrad's advice or consent (see Hall, 1885, p. xii). A fifth species (*"Avicula" angustirostra*), which was described but not figured by Conrad in the same report, was also considered by Hall (1884c, p. 115) to be a probable synonym of *A. boydii*.

Conrad originally cited the species *A. boydii* and *A. perobliqua* as coming from "Hamilton, Madison County" and *A. quadrula* was cited from nearby "Cazanovia, Madison County." There is little doubt that these three names refer to the same species and accordingly they are considered here to be synonyms. The two species *A. pleuroptera* from "near Smyrna, Chenango County" and *A. angustirostra* from "near Middleburg, Schoharie County" may be indistinguishable from *A. boydi,* but because the specimens on which these species were based may have come from Upper Devonian horizons, they are treated here as questioned synonyms.

It seems likely that future study of the Middle Devonian *Actinopteria* will show *A. boydi, A. decussata* and *A. subdecussata* to be one widely variable species and thus the two later names are also treated here as probable synonyms of *A. boydi*.

Actinopteria sp. A

(Plate 3, figures 21, 22)

A single well-preserved left valve from locality 22 and two fragments from locality 87 differ from *A. boydi* in being less oblique and having finer surface sculpture. These specimens probably represent a species closely related to or identical with many of the Ithaca, New York (Finger Lakes stage) specimens described by Hall (1884c, p. 118-128) under the names *Actinopteria perstrialis, tenuistriata, delta, epsilon, zeta, eta, theta, iota,* and *kappa*. Most or all of these names will probably prove to be synonyms but the true species limits will become adequately known only from restudy of the Ithaca material. Pending such study, no specific name will be used here for the Chemung specimens.

Actinopteria? sp. B

(Plate 3, figures 23, 24)

Four left valves from locality 84 differ from *A. boydi* in being more oblique and having larger auricles. All of the specimens are incomplete and none shows concentric sculpture, and therefore they cannot definitely be assigned to the genus *Actinopteria*. The specimens probably represent a new species, but the material is too poor to warrant a specific name.

Genus LEIOPTERIA

Author. Hall, 1883, p. 4.

Type species. *Leiopteria dekayi* Hall (1883, p. 8) by subsequent designation of Miller, 1889, p. 484.

Discussion. The validity of this genus and related pterioid genera has been treated in the discussion of the genus *Actinopteria*.

The genus is rare in the North American Upper Devonian with only three occurrences, in addition to these treated below, having been reported in the literature. These are:

1. The specimens from the Upper Devonian of Maryland described by Clarke and Swartz (1913, p. 634-636) as *Liopteria marylandica* and *Liopteria auriculata*. These specimens are doubtfully *Leiopteria* and neither species can be recognized without restudy.
2. The specimens from the Conewango stage of Chautauqua County, New York, described by Hall (1884c, p. 176) as *Leiopteria torreyi*. Hall's figures of the species appear to belong to the genus *Leptodesma* and the species cannot be recognized without restudy.
3. The specimens from the Conewango stage of western Pennsylvania described by Caster (1930, p. 56) as *Leiopteria cornelli*. These specimens probably represent a species of *Leiopteria*, but the occurrence needs restudy for adequate recognition.

Additional Upper Devonian (Finger Lakes stage) occurrences may be represented by the Schoharie County "Hamilton" specimens described by Hall (1884c, p. 162-168) under the names: *Leiopteria sayi, L. bigsbyi, L. mitchelli, L. troosti,* and *L. leai*.

The genus is thus known from the North American Upper Devonian only in the Appalachian area where it is of rare occurrence throughout the Upper Devonian.

Leiopteria nitida Hall

(Plate 5, figures 1-13, plate 6, figures 1-11)

Leiopteria nitidum Hall, 1883, p. 9, pl. 22, figs. 17, 18.
Avicula chemungensis Conrad. Vanuxem, 1842, p. 182, fig. 3.
Leiopteria chemungensis (Vanuxem). Hall, 1884b, p. 345. Hall, 1884c, p. 172, pl. 22, figs. 17, 18 [no such species described by Vanuxem, see discussion below].
Leiopteria linguiformis Hall, 1884c, p. 173, pl. 88, fig. 29. Willard, 1939, pl. 24, fig. 13.
Actinopteria zeta Hall. Lesley, 1889, p. 7.
Liopteria bigsbyi Hall. Clarke and Swartz, 1913, p. 634, pl. 62, fig. 12.

Revised description based on specimens from Chemung stage. Shell of medium size (median length of 27 specimens 26 mm), inequivalve, inequilateral. Both valves convex, right valve slightly less convex than left. Shape variable, height ranging from 80 to 126 percent of length. Prominent anterior auricle and extended posterior wing on both right and left valves. Auricle of left valve shows strong radial ridge in well-preserved composite molds (pl. 6, figs. 1-4); ridge absent on right valves. Hinge length equal to or exceeding greatest length of valve. Surface sculpture of very fine, evenly spaced concentric ridges on well-preserved right valves (pl. 5, figs. 7, 10, 12); left valves show more prominent and irregular concentric grooves and furrows. A single composite mold of a left valve shows

traces of two long lateral teeth along posterior hinge margin (pl. 6, figs. 1, 9); dentition otherwise unknown. Ligament area external, probably very narrow, represented on a few composite molds as a narrow impression along hinge line (pl. 5, fig. 9, pl. 6, fig. 8). Ligament grooves unknown. Musculature and interior features unknown. Shell material unknown.

Types. Holotype of *Leiopteria nitida* Hall, here designated, the specimen shown by Hall, 1883, as fig. 17 of pl. 22, No. 2633 in the New York State Museum, Albany, New York, U.S.A. (pl. 5, figs. 1-4). Type locality: Smith's Quarry [?], eight miles north of Binghamton, New York, U.S.A. Stratigraphic position: Upper Devonian, probably Chemung stage. Holotype of *Leiopteria linguiformis* Hall, here designated, the specimen shown by Hall, 1884c, as fig. 29 of pl. 88, No. 8870 in the New York State Museum, Albany, New York, U.S.A. (pl. 5, figs. 5, 6). Type locality: probably north of Binghamton, New York, U.S.A. Stratigraphic position: probably Upper Devonian.

Material. The revised description was based on 57 specimens from the Chemung stage, all of which are permanently deposited in the Yale Peabody Museum.

Occurrence. In New York this species is known with certainty only from the Chemung stage, although Hall's figured specimen (the holotype) may possibly have come from Finger Lakes stage horizons exposed north of Binghamton. This species, or others closely related to it, will undoubtedly be found to range through the Finger Lakes stage because almost identical forms are found in the New York Middle Devonian (see also the discussion below). The species is represented in the "Chemung" of Maryland by the single specimen figured as "*Liopteria bigsbyi*" by Clarke and Swartz (1913, pl. 62, fig. 12). A probable occurrence in the Cassadaga stage of Pennsylvania is indicated by the Bradford County specimen figured by Lesley (1889, p. 7) as "*Actinopteria zeta.*"

Within the Chemung stage the species was found at ten localities representing all but the highest generalized stratigraphic horizons. It was common only at localities 38 (15 specimens) and 94 (15 specimens), both representing the lower horizons of the stage.

Comparisons. This is the only Chemung stage species of the genus and thus it is unlikely to be misidentified.

Discussion. The nomenclature of this species is rather complicated and requires some comment. The specific name *Avicula chemungensis* was proposed with a description but no illustration by Conrad in 1842 (p. 243), the name being used for a radially sculptured pelecypod from Chemung Narrows (locality 22 of this report). This species was later figured by Hall as *Pterinea chemungensis* (Conrad) and is further described in this report as *Cornellites chemungensis* (Conrad). It seems probable that Conrad's radially sculptured species, though based on an inadequate description, was correctly identified by Hall. In 1842, the same year that *Avicula chemungensis* was originally described by Conrad, Vanuxem figured a specimen which he called simply *Avicula chemungensis,* with no author given. The specimen lacks radial sculpture and is a typical *Leiopteria.* On the third page following Vanuxem's figure he clearly attributed the species name *A. chemungensis* to Conrad when he included it in a list which "presents all the fossils belonging to the Chemung group, which have been identified and named by Mr. Conrad up to this time." So far, then, we have a simple case of Vanuxem misidentifying Conrad's species.

Further complications arose when, in the 1883 preliminary edition of the pelecypod plates, Hall unknowingly refigured Vanuxem's earlier illustrated specimen as the new species *Leiopteria nitidum* (Hall, 1883, p. 9, pl. 22, figs. 17, 18). This was of course quite valid, an originally misidentified specimen being used, even though unknowingly, as the basis of a new species. Had things ended here all would be well, but in the same report (p. 8) Hall made the following statement in a footnote to his newly defined Middle Devonian species *Leiopteria dekayi:* "this is probably the species described by Mr. Vanuxem as *Avicula chemungensis,* in the Geol. Rept., Third District, N. Y. At that time the rock formations at Norwich, and several other localities, were considered as Chemung. They have since been found to belong to the Hamilton Group; and the nomenclature of some of the species is therefore objectionable on this account." It is apparent, therefore, that Hall thought Vanuxem was proposing a *new* species called *Avicula chemungensis*

whereas he was actually only applying Conrad's earlier name, as has been shown above. In summary then, Hall in 1883 cited Vanuxem's specimen as a subjective synonym of *L. dekayi* while at the same time unknowingly figuring it as the new species *L. nitidum.*

The confusion was further compounded before the final report appeared when Hall realized that it was Vanuxem's specimen that he had figured as *L. nitidum.* In the final 1884 report Hall changed the identification of Vanuxem's specimen to *Leiopteria chemungensis* (Vanuxem), citing *L. nitidum* as a synonym and explaining: "In the volume of Plates and Explanations this species was referred to *L. dekayi* in the absence of the original specimen, which has since been compared and found to belong to the Chemung group." Since Vanuxem proposed no such species, Hall's identification cannot stand. Clearly the only valid name ever applied to Vanuxem's original figured specimen is *L. nitidum* Hall, 1883, and this name is used here for the Chemung specimens which I regard as conspecific with Vanuxem's original figured specimen.

A final and more significant problem concerns the specific distinctiveness of the Middle and Upper Devonian specimens assigned to *Leiopteria* by Hall. Hall's 12 Middle Devonian species of *Leiopteria* are almost certainly the same species or, at the most, 2 or 3 species. Furthermore, the Chemung specimens described here are indistinguishable from most New York Middle Devonian specimens of *Leiopteria* in the collections of the Yale Peabody Museum. Pending complete revision of the Middle Devonian species, I am tentatively retaining a separate name for the Upper Devonian specimens of *Leiopteria.* This is done with the knowledge that future revision of the Middle Devonian forms will probably require a change in the specific name of the Chemung specimens.

Genus LEPTODESMA

Author. Hall, 1883, p. 4.

Type species. *Leptodesma potens* Hall (1883, p. 9) by subsequent designation of Miller, 1889, p. 484.

Discussion. The validity of the genus has been treated in the discussion of the genus *Actinopteria.*

This is the most abundant pelecypod genus in the New York Upper Devonian, specimens being common in all the Upper Devonian stages except the Finger Lakes where few specimens have been reported, possibly because of inadequate collecting.

Hall, in his final report of 1884 (Hall, 1884c), recognized 54 Upper Devonian species of *Leptodesma,* their stratigraphic distribution being approximately as follows (based primarily on Chadwick, 1935a. Species noted from more than one stage are counted from the stage in which they are most common, as based on the localities of Hall's figured specimens):

Conewango stage:	11 species
Cassadaga stage:	26 species
Chemung stage:	15 species
Finger Lakes stage:	2 species

For the present study I have considered only the 15 Chemung and 2 Finger Lakes "species." Analysis of shape variability in single samples of Chemung stage *Leptodesma* has shown that these 17 specific names represent only 2 valid species (see below). Similar reductions may be expected from critical restudy of the 37 post-Chemung specific names, although these revisions will be more difficult because many of Hall's figured specimens from these younger rocks appear to be inappropriately assigned to the genus *Leptodesma.*[1]

[1] An informative aside on variation in the genus is provided in the imaginative little paper by Clarke (1894) on "Composite Generic Fundamenta" in which outline drawings of all of Hall's species of *Leptodesma* are superimposed to give a "fundamentum" or typical shape for the genus. Not surprisingly, Clarke concluded that *Leptodesma rogersi* (*L. spinigerum* of this report) is the "typical species" of the genus. Other interpretations will be apparent to the reader. The

Six species of the genus appear to have been described from the North American Upper Devonian since Hall's report, which included all earlier species. These are:

1. *Leptodesma transversa* Walcott (1884, p. 167, pl. 5, fig. 13) from the Upper Devonian of Nevada. This species is possibly *L. naviforme* of the New York Devonian, but it cannot be recognized without restudy.
2. *Leptodesma leiopteroides* Simpson (1890, p. 447, fig. 13) from the Conewango stage at Warren, Pennsylvania. This is doubtfully a *Leptodesma.*
3. *Leptodesma parallelum* Simpson (1890, p. 448, fig. 14) also from the Conewango stage at Warren, Pennsylvania. This is not a *Leptodesma.*
4. *Leptodesma eolus* Kindle (1909, p. 32, pl. 10, fig. 3) from the Ouray limestone of Colorado. This is doubtfully a *Leptodesma.*
5. *Leptodesma elongatum* Clarke and Swartz (1913, p. 640, pl. 63, fig. 20) from the "Chemung" of Maryland. This will probably prove to be a synonym of some earlier New York name.
6. *Leptodesma carinifera* Caster (1930, p. 54, pl. 24, fig. 3) from the Conewango stage at Smethport, Pennsylvania. This is doubtfully a *Leptodesma.*

The genus is apparently rare in the North American Lower and Middle Devonian, the few known specimens having been described under various specific names by Hall (1884c, p. 175), Kindle (1900, p. 671), Prosser and Kindle (1913, p. 254), Branson (1922, p. 151), Cooper and Cloud (1938, p. 452), and La Rocque (1950, p. 286; this is doubtfully a *Leptodesma,* in my opinion). Most of the specimens figured by these authors appear to be very similar to the Chemung species *L. spinigerum,* but all are in need of critical restudy.

Leptodesma naviforme Hall

(Plate 7, figures 1-18, plate 8, figures 1-10)

Leptodesma naviforme Hall, 1883, p. 9, 10, pl. 22, fig. 15, pl. 23, fig. 1. Hall, 1884b, p. 367. Hall, 1884c, p. 200, pl. 22, fig. 15, pl. 23, fig. 1. Clarke and Swartz, 1913, p. 639, pl. 63, figs. 16, 17. [?] Willard, 1939, pl. 25, fig. 4.

Revised description based on specimens from Chemung stage. Shell of medium size (median length of 72 specimens 13 mm), inequivalve, inequilateral, biconvex, right valve slightly less convex than left. Shape extremely variable, height ranging from 59 to 100 percent of length. Hinge line straight from anterior extremity to posterior wing where the hinge line is drawn out into a short spine, the spine being very seldom preserved (see pl. 7, figs. 9, 15). Obscure to prominent surface sculpture of fine to coarse, irregularly spaced concentric ridges and furrows on both valves. Small specimens show regular, concentric ridges (pl. 8, fig. 10). Well-preserved right valves show obscure traces of radial sculpture (pl. 8, figs. 2-7); a few left valve composite molds also show very faint traces of radial sculpture (pl. 7, fig. 14). Dentition and hinge features unknown, teeth probably very small or absent (no impression of dentition on any composite mold). Ligament unknown. Musculature and interior features unknown. Shell material unknown.

Types. Holotype of *Leptodesma naviforme* Hall, here designated, the specimen shown

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rise of population systematics came long after Clarke's paper, so he may be excused for having stated (1894, p. 286-287):

> "The genus [*Leptodesma*] in some of the higher beds of the Chemung group is enormously prolific, so that the perception and identification of these 55 specific values [of Hall's 1884 report] is a puzzle to which the identification of Jurassic Ammonites or recent Unios is but play. Nevertheless, no more instructive series of variations of a single generic type has ever been described among Palaeozoic fossils. The first onset at such a group is certain to lay the student low with acute brain-fag, and leave upon his mind a hazy conviction that all the alleged species are pretty much one and the same thing. The beauty of the series and the persistence of its variations or species dawns upon the mind gradually but invincibly."

by Hall, 1884c, as fig. 1 of pl. 23, No. 6097/1:1 in the American Museum of Natural History, New York, New York, U.S.A. (pl. 7, figs. 1, 2). Type locality: near Ithaca, New York, U.S.A. Stratigraphic position: Upper Devonian, probably Finger Lakes stage.

MATERIAL. The revised description was based on 241 specimens from the Chemung stage, all of which are permanently deposited in the Yale Peabody Museum.

OCCURRENCE. The species was found only at localities 30 and 38, which represent the lowest horizons of the stage. It was of common occurrence at both localities. *L. naviforme* was never found with *L. spinigerum* which occurred at all other localities where the genus was recognized.

L. naviforme is known in New York outside the Chemung stage only from Hall's original figured specimens from the Finger Lakes stage. The specimens figured by Clarke and Swartz (1913, pl. 63, figs. 16, 17) from the Upper Devonian of Maryland are probably correctly identified as this species.

COMPARISONS. The species is very similar to *L. spinigerum* but is distinguishable in large collections by the faint radial sculpture of the right valves, lack of a prominent anterior groove and marginal indentation, and by the shorter posterior spine, when preserved. Small lots of isolated or poorly preserved specimens might prove indistinguishable from *L. spinigerum*.

DISCUSSION. See *Leptodesma spinigerum*.

Leptodesma spinigerum (Conrad)

(Plate 8, figures 11, 12; plate 9, figures 1-22; plate 10, figures 1-27; plate 11, figures 1-21)

Avicula spinigera Conrad, 1842, p. 237, pl. 12, fig. 3. Hall, 1843, p. 263, p. 262, fig. 4.
Pteronites spinigerus (Conrad). Miller, 1877, p. 202.
Leptodesma spinigerum (Conrad). Hall, 1883, p. 9, pl. 21, figs. 10-13. Hall, 1884b, p. 349. Hall, 1884c, p. 177, pl. 21, figs. 10-13, pl. 89, fig. 1.
Avicula protexta Conrad, 1842, p. 238, pl. 12, fig. 6.
Pterinea protexta (Conrad). Miller, 1877, p. 202.
Leptodesma protextum (Conrad). Hall, 1883, p. 9, pl. 21, figs. 22, 23. Hall, 1884b, p. 354. Hall, 1884c, p. 183, pl. 21, figs. 22, 23.
Avicula longispina Hall, 1843, p. 263, p. 262, fig. 3.
Pterinea longispina (Hall). Miller, 1877, p. 202.
Leptodesma longispinum (Hall). Hall, 1883, p. 9, pl. 21, figs. 14, 17-19. Hall, 1884a, pl. 4, fig. 12. Hall, 1884b, p. 350, pl. 4, fig. 12. Hall, 1884c, p. 179, pl. 21, figs. 14, 17-19, pl. 89, figs. 2-4. Clarke and Swartz, 1913, p. 637, pl. 63, figs. 4-8. [?] Willard, 1939, pl. 25, fig. 2.
Leptodesma rogersi Hall, 1883, p. 9, pl. 21, figs. 1-9. Hall, 1884b, p. 348. Hall, 1884c, p. 176, pl. 21, figs. 1-9. [?] Kindle, 1900, pl. 671, pl. 13, figs. 3-3b. [?] Prosser and Kindle, 1913, p. 254, pl. 29, figs. 7-10. Clarke and Swartz, 1913, p. 636, pl. 63, fig. 3.
Leptodesma robustum Hall, 1883, p. 9, pl. 12, figs. 15, 16, 20. Hall, 1884b, p. 252. Hall, 1884c, p. 181, pl. 21, figs. 15, 16, 20, pl. 89, fig. 8.
Leptodesma becki Hall, 1883, p. 9, pl. 22, figs. 3-7. Hall, 1884b, p. 355. Hall, 1884c, p. 185, pl. 22, figs. 3-5. [?] Willard, 1939, pl. 24, fig. 19.
Leptodesma shumardi Hall, 1884c, p. 180, pl. 89, figs. 5, 6. Hall, 1884b, p. 351.
Leptodesma agassizi Hall, 1884c, p. 182, pl. 89, figs. 17-19. Hall, 1884b, p. 353. Clarke and Swartz, 1913, p. 637, pl. 63, figs. 9, 10.
Leptodesma medon Hall, 1884c, p. 197, pl. 90, figs. 1-4. Hall, 1884b, p. 365. Clarke and Swartz, 1913, p. 638, pl. 63, figs. 11-15. [?] Nalivkin, 1934, p. 16, pl. 1, fig. 8. [?] Willard, 1939, pl. 24, fig. 22.
Leptodesma creon Hall, 1884c, p. 202, pl. 90, figs. 11-13. Hall, 1884b, p. 368. [?] Willard, 1939, pl. 24, fig. 17.
Leptodesma demus Hall, 1884c, p. 203, pl. 90, figs. 15, 16. Hall, 1884b, p. 369. [?] Whiteaves, 1891, p. 240, pl. 32, fig. 7.
Leptodesma loxias Hall, 1884c, p. 204, pl. 90, fig. 14. Hall, 1884b, p. 370.
Leptodesma flaccidum Hall, 1884c, p. 225, pl. 91, fig. 9. Hall, 1884a, pl. 4, fig. 15. Hall, 1884b, p. 386, pl. 4, fig. 15.
[?] *Leptodesma quadratum* Hall, 1884c, p. 233, pl. 91, fig. 15 [later references omitted].
[?] *Leptodesma lesleyi* Hall, 1884c, p. 223, pl. 91, fig. 7 [later references omitted].

Revised description based on specimens from Chemung stage. Shell of medium size (median length of 112 left valves from locality 102, 16 mm), inequivalve, inequilateral, biconvex, right valve slightly less convex than left. Shape extremely variable, height ranging from 59 to 100 percent of length. Hinge line straight from anterior extremity to posterior wing where the hinge line is drawn out into a long spine which is commonly not preserved. Anterior-ventral margin with slight indentation below umbo (byssal notch?) making groove of varying prominence extending ventrally from umbo to margin, groove most prominent on right valve. Surface sculpture of fine to coarse, irregularly spaced concentric ridges and furrows on both valves, but sculpture generally finer and somewhat more regularly spaced on right valves. A few well-preserved left valve composite molds show very fine and regular, widely spaced concentric ridges (pl. 9, figs. 15, 17, 19, 21). Concentric sculpture more prominent anteriorly. Well-preserved left valves show very faint traces of fine, discontinuous radial sculpture (pl. 9, figs. 9, 17). Dentition and hinge features unknown, teeth probably very small or absent (no impression of dentition on any composite mold). Ligament unknown, ligament area, if external, probably very narrow or confined to umbonal region (no impression of ligament grooves seen along hinge of any composite mold). Musculature and interior features unknown. Shell material unknown.

Types. Holotype of *Leptodesma spinigerum* (Conrad), here designated, the specimen shown by Conrad, 1842, as fig. 3 of pl. 12, whereabouts unknown. Type locality: Chemung Narrows, New York [locality 22 of this report]. Stratigraphic position: Upper Devonian, Chemung stage. Conrad's types are presumably lost but they may be as yet unrecognized in the various Hall collections. No neotype is necessary because the species is easily identifiable from Conrad's figure and the occurrence at Narrow Hill. Holotype of *Avicula protexta* Conrad, here designated, Conrad's paratype shown by Hall, 1884c, as fig. 22 of pl. 21, No. 6099/1:1 in the American Museum of Natural History, New York, New York, U.S.A. (pl. 9, fig. 4). Type locality: Chemung River, Upper Narrows, New York, U.S.A. [locality 22 of this report]. Stratigraphic position: Upper Devonian, Chemung stage. Holotype of *Avicula longispina* Hall, here designated, the specimen shown by Hall, 1843, as fig. 3, p. 262, and by Hall, 1884c, as fig. 14 of pl. 21, No. 6094/1:1 in the American Museum of Natural History, New York, New York, U.S.A. (pl. 9, fig. 16). Type locality: Painted Post, Steuben County, New York, U.S.A. Stratigraphic position: Upper Devonian, probably Chemung stage. Holotype of *Leptodesma rogersi*, here designated, the specimen shown by Hall, 1883, as fig. 4 of pl. 21, No. 2595 in the New York State Museum, Albany, New York, U.S.A. (pl. 9, fig. 14). Type locality: Norwich, Chenango County, New York, U.S.A. Stratigraphic position: Upper Devonian, probably Finger Lakes stage. Holotype of *Leptodesma robustum* Hall, here designated, the specimen shown by Hall, 1883, as fig. 16 of pl. 21, No. 6100/1:1 in the American Museum of Natural History, New York, New York, U.S.A. (pl. 9, fig. 18). Type locality: Painted Post, Steuben County, New York, U.S.A. Stratigraphic position: Upper Devonian, probably Chemung stage. Holotype of *Leptodesma becki* Hall, here designated, the specimen shown by Hall, 1883, as fig. 5 of pl. 22 No. 6090/1:1 in the American Museum of Natural History, New York, New York, U.S.A. (pl. 10, fig. 1). Type locality: Corning, Steuben County, New York, U.S.A. Stratigraphic position: Upper Devonian, probably Chemung stage. Holotype of *Leptodesma shumardi* Hall, here designated, the specimen shown by Hall, 1884c, as fig. 5 of pl. 89, No. 2602 in the New York State Museum, Albany, New York, U.S.A. (pl. 9, fig. 20). Type locality: between Elmira, Chemung County and Corning, Steuben County, New York, U.S.A. Stratigraphic position: Upper Devonian, probably Chemung stage. Holotype of *Leptodesma agassizi* Hall, here designated, the specimen shown by Hall, 1884c, as fig. 18 of pl. 89, No. 2517 in the New York State Museum, Albany, New York, U.S.A. (pl. 9, fig. 10). Type locality: Chemung River between Elmira and Waverly, New York, U.S.A. Stratigraphic position: Upper Devonian, Chemung stage. Holotype of *Leptodesma medon* Hall, here designated, the specimen shown by Hall, 1884c, as fig. 1 of pl. 90, No. 2562 in the New York State Museum, Albany, New York, U.S.A. (pl. 9, fig. 22). Type locality: Lawrenceville, Tioga County, Pennsylvania, U.S.A. Stratigraphic position: Upper Devonian, probably Chemung stage. Holotype of *Leptodesma creon* Hall, here designated, the specimen shown by Hall,

1884c, as fig. 12 of pl. 90, No. 2532 in the New York State Museum, Albany, New York, U.S.A. (pl. 9, fig. 12). Type locality: Lawrenceville, Tioga County, Pennsylvania, U.S.A. Stratigraphic position: Upper Devonian, probably Chemung stage. Holotype of *Leptodesma demus* Hall, here designated, the specimen shown by Hall, 1884c, as fig. 16 of pl. 90, No. 2536 in the New York State Museum, Albany, New York, U.S.A. (pl. 9, fig. 8). Type locality: Lawrenceville, Tioga County, Pennsylvania, U.S.A. Stratigraphic position: Upper Devonian, probably Chemung stage. Holotype of *Leptodesma loxias* Hall, here designated, the specimen shown by Hall, 1884c, as fig. 14 of pl. 90, No. 2554 in the New York State Museum, Albany, New York, U.S.A. (pl. 9, fig. 6). Type locality: Lawrenceville, Tioga County, Pennsylvania, U.S.A. Stratigraphic position: Upper Devonian, probably Chemung stage. Holotype of *Leptodesma flaccidum,* here designated, the specimen shown by Hall, 1884c, as fig. 9 of pl. 91, whereabouts unknown. Type locality: Lawrenceville, Tioga County, Pennsylvania, U.S.A. Stratigraphic position: Upper Devonian, probably Chemung stage.

Material. The revised description was based on about 1,100 specimens from the Chemung stage, all of which are permanently deposited in the Yale Peabody Museum.

Occurrence. This is the most abundant Chemung stage pelecypod. It was found at 16 localities representing all but the lowest horizons of the stage. It was most common at localities 102 (525 specimens) and 23B (185 specimens).

The species is apparently common in the Finger Lakes stage of New York, where it is represented by Hall's specimens of *L. rogersi* from the "Hamilton" of Chenango County. The Middle Devonian specimens identified as *L. rogersi* by later authors cannot be assigned to *L. spinigerum* without restudy. The range of the species in the post-Chemung Upper Devonian cannot be determined until the many post-Chemung "species" have been revised, but it ranges at least into the Cassadaga stage and possibly higher.

The species is represented in the Upper Devonian of Maryland by the specimens figured by Clarke and Swartz (1913) as *L. longispinum, L. rogersi, L. agassizi,* and *L. medon.*

Comparisons. See *Leptodesma naviforme.*

Discussion. A single bedding plane at locality 102 yielded more than 500 complete specimens of *Leptodesma* and this material has served as the basis for defining the Chemung species of the genus. Many of the specimens were preserved with the valves articulated and this, coupled with the abundance and excellent preservation of the specimens, leaves little room for doubt that the specimens represent a single living population of one species. This material shows that the widest latitude in shape variation must be allowed if biologically meaningful species are to be defined in the genus (see pl. 9 which compares specimens from this locality with the holotypes of 11 earlier "species"). Suites of *Leptodesma* from other localities, where the genus was always less common and more poorly preserved, were compared with the locality 102 specimens and most were found to fall within the range of shape variation demonstrated by this material. Consistent differences in ornamentation and somewhat more subjective shape differences do, however, permit the recognition of a second Chemung stage species, *L. naviforme.*

The Chemung material has shown 13 species names, all of them based on Chemung stage holotypes, to be subjective synonyms (see pl. 9). The earliest valid name for this species is *Leptodesma spinigerum* (Conrad). The two Chemung species *Leptodesma lesleyi* Hall and *Leptodesma quadratum* Hall probably represent this species, but the specimens on which they are based are too distorted for final determination.

Genus CORNELLITES

Author. Williams, 1908, p. 89.

Type species. *Pterinea fasciculata* Goldfuss (1840, p. 137) by original designation.

Discussion. The distinctive Chemung stage specimens assigned by Hall to the genus *Pterinea* have many similarities to the German Lower Devonian type species of Williams' genus *Cornellites.* Among these similarities are the general shape, radially sculptured left

valve, and the flattened right valve with radial ridges only on the anterior-dorsal region. The dentition in the two species is also probably quite similar (compare pl. 14, fig. 6 with Frech, 1891, pl. 8, fig. 1). The Chemung species, however, differs in lacking the fine concentric sculpture, having much finer radial sculpture (suggestive of some species of the genus *Limoptera*) and in having a much differently shaped anterior auricle. Future revision of the Devonian pterioid genera may show the Chemung species to be generically distinctive but pending such revision Williams' generic name will be used here (see also the discussion of the genus *Actinopteria*).

Only two species of *"Pterinea,"* excluding those treated below, appear to have been described from the North American Upper Devonian. These are *Pterinea husseyi* Fenton and Fenton (1924, p. 175) from the Upper Devonian of Iowa and *Pterinea newarkensis* Walcott (1884, p. 165) from the Upper Devonian of Nevada. Both of these species are based on single poorly preserved specimens, and neither can be adequately recognized without restudy.

Hall (1884c, pl. 83, fig. 11) illustrated a single Chemung stage specimen as the Middle Devonian species *"Pterinea" flabella,* but on examining the specimen I found it to be in a glacial boulder of unknown origin and to be very doubtfully *P. flabella.* This occurrence must thus be discounted.

Cornellites chemungensis (Conrad)

(Plate 12, figures 1-6; plate 13, figures 1-7; plate 14, figures 1-9)

Avicula chemungensis Conrad, 1842, p. 243. [not] Vanuxem, 1842, p. 182, fig. 3.
Pterinea chemungensis (Conrad). Miller, 1877, p. 201. Hall, 1883, p. 8, pl. 16, figs. 3, 7, 10, 12. Hall, 1884a, pl. 3, fig. 4. Hall, 1884b, p. 289, pl. 3, fig. 4. Hall, 1884c, p. 98, pl. 16, figs. 3, 7, 10, 12, pl. 84, fig. 21. Clarke and Swartz, 1913, p. 629, pl. 61, fig. 22. [not] Willard, 1939, pl. 23, fig. 11.
Avicula pecteniformis Hall, 1843, p. 263, p. 262, figs. 1, 2.
Pterinea consimilis Hall, 1883, p. 8, pl. 16, figs. 1, 2, 8, 9, 11. Hall, 1884b, p. 291. Hall, 1884c, p. 100, pl. 16, figs. 1, 2, 8, 9, 11, pl. 84, [?] fig. 23. [?] Willard, 1939, pl. 23, fig. 14.
Pterinea rigida Hall, 1883, p. 8, pl. 15, figs. 5, 6. Hall, 1884b, p. 292. Hall, 1884c, p. 101, pl. 16, figs. 5, 6.
Pterinea prora Hall, 1883, p. 8, pl. 16, figs. 4, 13, 14. [?] Willard, 1939, pl. 23, fig. 15.
Pterinea interstrialis Hall, 1884c, p. 96, pl. 84, fig. 22. [?] Willard, 1939, pl. 23, fig. 13.
[?] *Pterinea dispanda* Hall, 1883, p. 7, pl. 15, fig. 7 [later references omitted].
[?]*Pterinea nodocosta* Clarke and Swartz, 1913, p. 628, pl. 61, figs. 19-21 [later references omitted].

Revised description based on specimens from Chemung stage. Shell large (median length of 43 specimens 38 mm), inequivalve, inequilateral. Left valve convex, right valve slightly convex in umbonal region, becoming flat or slightly concave marginally. Shape extremely variable, height ranging from 73 to 142 percent of length (see fig. 3). Prominent anterior auricle and posterior wing on both right and left valves, relative length of both auricle and wing variable. Hinge length equal to or exceeding greatest length of valve. Surface sculpture on both body and auricle of left valve consisting of 20 to 40 prominent, thin, irregularly spaced, first-order radial ridges with wide, flat interspaces. Most specimens also show a few finer second-order radial ridges in the interspaces. Well-preserved composite molds of left valve also show very fine concentric ridges (pl. 13, fig. 6, pl. 14, fig. 1). Surface sculpture of right valve consists of about twelve radial ridges on posterior wing only, rest of valve showing only faint concentric ridges in well-preserved composite molds (pl. 14, figs. 3-5, 7). Dentition of left valve known from a single internal mold (pl. 14, figs. 6, 8) which shows three faint cardinal teeth and two strong, oblique lateral teeth, dentition otherwise unknown. Ligament of external chevron-groove type with numerous very fine ligament grooves, the grooves commonly being preserved as impressions of ligament area along hinge line of composite molds (pl. 12, fig. 2, pl. 14, figs. 2, 5). Musculature and interior features unknown. A single internal mold retains traces of much-altered shell material (pl. 14, fig. 8), shell material otherwise unknown.

TYPES. Conrad published no figures with his original description of *"Avicula" chemungensis* and his original specimens are probably lost. The species, however, presents no difficulties of nomenclature or recognition. Holotype of *Avicula pecteniformis* Hall, here designated, the specimen shown by Hall, 1843, as fig. 1, p. 262, and by Hall, 1884c, as fig. 10 of pl. 16, No. 6073/2 in the American Museum of Natural History, New York, New York, U.S.A. (pl. 12, figs. 1, 2). Type locality: Chemung Narrows, New York, U.S.A. [locality 22 of this report]. Stratigraphic position: Upper Devonian, Chemung stage. Holotype of *Pterinea consimilis* Hall, here designated, the specimen shown by Hall, 1884c, as fig. 11 of pl. 16, No. 6076/1:1 in the American Museum of Natural History, New York, New York, U.S.A. (pl. 12, fig. 5). Type locality: near Elmira, New York, U.S.A. Stratigraphic position: Upper Devonian, probably Chemung stage. Holotype of *Pterinea rigida* Hall, here designated, the specimen shown by Hall, 1884c, as fig. 6 of pl. 16, No. 6080/2 in the American Museum of Natural History, New York, New York, U.S.A. (pl. 12, fig. 3). Type locality: Chemung, New York, U.S.A. [probably locality 22 of this report]. Stratigraphic position: Upper Devonian, Chemung stage. Holotype of *Pterinea prora* Hall, here designated, the specimen shown by Hall, 1884c, as fig. 13 of pl. 16, No. 6079/1:1 in the American Museum of Natural History, New York, New York, U.S.A. (pl. 12 fig. 4). Type locality: near Elmira, New York, U.S.A. Stratigraphic position: Upper Devonian, probably Chemung stage. Holotype of *Pterinea interstrialis* Hall, here designated, the specimen shown by Hall, 1884c, as fig. 22 of pl. 84, No. 3044 in the New York State Museum, Albany, New York, U.S.A. (pl. 12, fig. 6). Type locality: Chemung Narrows, New York, U.S.A. [locality 22 of this report]. Stratigraphic position: Upper Devonian, Chemung stage.

MATERIAL. The revised description was based on 115 specimens from the Chemung stage, all of which are permanently deposited in the Yale Peabody Museum. A single additional specimen from the Hall collections of the New York State Museum shows the dentition of the species (pl. 14, figs. 6, 8).

OCCURRENCE. This distinctive species is abundant in the sandier horizons of the middle Chemung stage. It is common at localities 22, 23A, 53, and 66 but is rare elsewhere in the stage, being represented by only a few specimens from higher and lower horizons.

The species is unknown with certainty outside the Chemung stage in New York and northern Pennsylvania. It was reported by Clarke and Swartz (1913, p. 629) from possibly pre-Chemung horizons in Maryland, but these occurrences need further confirmation. The Cassadaga stage specimen called *Pterinea dispanda* by Hall may represent a post-Chemung occurrence of *C. chemungensis.*

COMPARISONS. This distinctive species is unlikely to be confused with other Chemung stage pelecypods.

DISCUSSION. The well-illustrated species *Avicula pecteniformis* Hall (1843) was considered by Hall (1884c) as a synonym of the originally unillustrated species *Avicula chemungensis* Conrad (1842), a decision possibly made with Conrad's advice or consent (see Hall, 1884c, p. viii). Both of these species were based on specimens from Chemung Narrows (locality 22 of this report). As thus established, the species is clearly defined although it could never be recognized if Conrad's original description were the only evidence for its identity.

Hall's later species *Pterinea consimilis, P. rigida, P. prora,* and *P. interstrialis* were defined on minor differences in shape among Chemung stage specimens which are clearly gradational and indistinguishable from *C. chemungensis* (see fig. 3). The species *P. dispanda* Hall from the Cassadaga stage and *P. nodocosta* Clarke and Swartz from the "Chemung" of Maryland may be distinctive species, but neither can be recognized without restudy.

The species has been widely regarded as an index fossil to the "type" Chemung (see Williams, 1907, and Chadwick, 1935a), an empirical conclusion based on its apparent absence elsewhere in the New York Upper Devonian. Non-Chemung occurrences are to be expected, however, because the value of the species as a guide fossil is not yet based on evolutionary evidence and its distribution is undoubtedly strongly influenced by shifts in the sandier depositional environment.

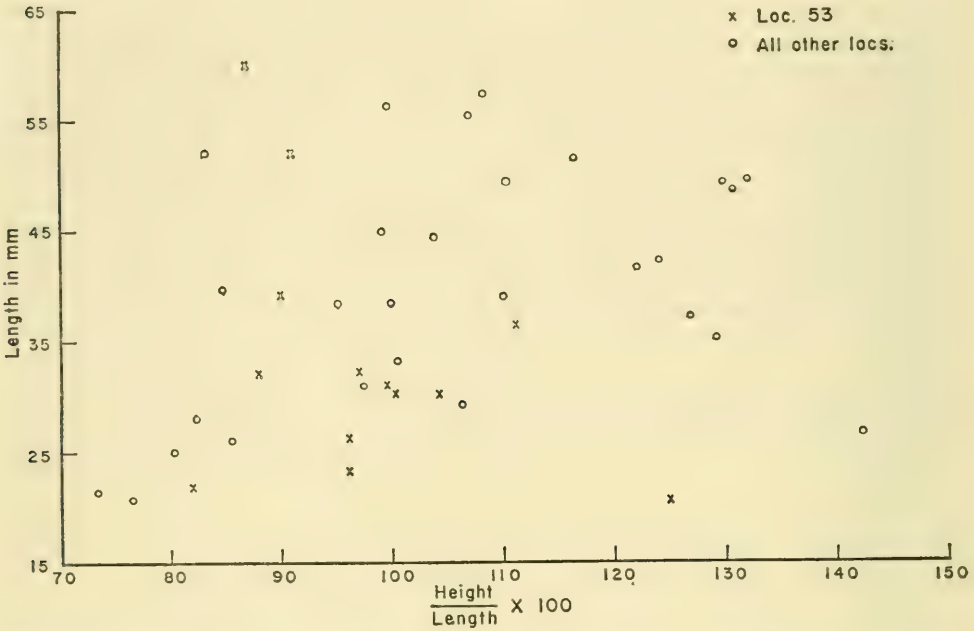

Figure 3. *Cornellites chemungensis*. Scatter diagram of length X form ratio (height expressed as percentage of length), showing size and shape variation of all measurable Chemung stage specimens. Note the range of shape variation in specimens from locality 53, the locality at which the species is most common.

Genus MYTILARCA

Author. Hall and Whitfield, 1869, p. 19.

Type species. *Inoceramus chemungensis* Conrad (1842, p. 246) by original designation.

Discussion. The genus name is used here for the externally ligamented Chemung mytiloid species, *M. chemungensis* (Conrad), upon which the genus was founded. Newell, in his revision of the post-Mississippian mytiloids (1942), apparently considered *Mytilarca* a valid genus, for he compared it with his Pennsylvanian genus *Selenimyalina* (p. 63). Many other generic names have been proposed for early Paleozoic mytiloids and complete generic revision will be necessary before any genus name can be used with certainty (see also the discussion below of *M. chemungensis*).

The only species of the genus that have been recognized in the North American Upper Devonian are the eight species reported by Hall in his final report (1884c, p. 258-262). Three of these (*M. attenuata, carinata,* and *chemungensis*) are here considered to be subjective synonyms. The other five (*M. gibbosa, lata, regularis, simplex,* and *umbonata*) are all based on inadequate material from the Upper Devonian (mostly post-Chemung units) of New York and northern Pennsylvania, and none can be recognized without restudy.

Important generic discussions include those of Frech (1891), Isberg (1934), Maillieux (1937), and Newell (1942).

Mytilarca chemungensis (Conrad)

(Plate 15, figures 1-18; plate 16, figure 1)

Inoceramus chemungensis Conrad, 1842, p. 246, pl. 13, fig. 9.
Mytilarca chemungensis (Conrad). Hall and Whitfield, 1869, p. 23. Hall, 1873, pl. 14, figs. 11-13.

Hall, 1883, p. 11, pl. 32, figs. 7-14, pl. 33, fig. 8. Hall, 1884a, pl. 5, figs. 5, 6. Hall, 1884c, p. 258, pl. 32, figs. 8-11, 13, 14. [?] Walcott, 1884, p. 168, pl. 4, fig. 9. [?] Butts, 1941, p. 211, pl. 122, fig. 9.

Mytilarca attenuata Hall and Whitfield, 1869, p. 23.

Mytilarca attenuata Hall [and Whitfield]. Hall, 1883, p. 11, pl. 32, fig. 20. Hall, 1884c, p. 260, pl. 32, fig. 20.

Mytilarca carinata Hall, 1883, p. 11, pl. 32, figs. 15-19. Hall ms. in Miller, 1877, p. 197 [nomen nudem]. Hall, 1884a, pl. 5, figs. 7, 8. Hall, 1884b, p. 402, pl. 5, figs. 7, 8. Hall, 1884c, p. 259, pl. 32, figs. 15-19, pl. 33, fig. 8.

[not] *Mytilus chemungensis* (Conrad). Phillips and Salter, 1848, p. 365, pl. 20, figs. 10, 11.

Revised description based on specimens from Chemung stage. Shell of medium size (median length of 38 specimens 25 mm), equivalve or subequivalve, inequilateral, moderately inflated. Shape variable, height ranging from 42 to 65 percent of length. Margins variable, dorsal margin usually broadly convex, commonly straight in anterior (hinge) region. Ventral margin straight or slightly concave, anterior marginal lobe absent or very small. Umbones in extreme anterior position. Surface sculpture of faint, irregularly spaced concentric ridges and furrows present on well-preserved composite molds (pl. 15, figs. 10, 11, 14). A single composite mold shows very obscure impression of one or two oblique cardinal teeth and two oblique posterior teeth (pl. 15, fig. 4), dentition otherwise unknown. Ligament of external, chevron-groove type obscurely represented on several composite molds (pl. 15, figs. 1, 13) as impressions of finely grooved ligament area along anterior part of dorsal margin. Musculature and interior features unknown. Shell material unknown.

Types. Holotype of *Mytilarca chemungensis* (Conrad), here designated, the specimen shown by Conrad, 1842, as fig. 9 of pl. 13, whereabouts unknown. Type locality: Chemung Narrows, New York, U.S.A. [locality 22 of this report]. Stratigraphic position: Upper Devonian, Chemung stage. Holotype of *Mytilarca carinata* Hall, here designated, the specimen shown by Hall, 1884c, as fig. 18 of pl. 32, No. 6109/2:1 in the American Museum of Natural History, New York, New York, U.S.A. (pl. 15, figs. 1, 2). Type locality: near Elmira, New York, U.S.A. Stratigraphic position: Upper Devonian, probably Chemung stage. Holotype of *Mytilarca attenuata* Hall and Whitfield, here designated, the specimen shown by Hall, 1884c, as fig. 20 of pl. 32, No. 2824 in the New York State Museum, Albany, New York, U.S.A. (pl. 16, fig. 1). Type locality: Elmira, New York, U.S.A. [probably from glacial boulder of unknown origin]. Stratigraphic position: unknown.

Material. The revised description was based on about 75 specimens from the Chemung stage. Of these, 59 are permanently deposited in the Yale Peabody Museum and the others are from the Hall collections at the American Museum of Natural History (see figured specimens).

Occurrence. The species as defined here is known with certainty only from the Chemung and Cassadaga stages in New York and northern Pennsylvania. Specimens reported from the Upper Devonian of Virginia (Butts, 1941) and Nevada (Walcott, 1884) need confirmation but may prove to be this species. Within the Chemung stage the species was found to be abundant only at locality 75, although it occurred sparingly at five other localities. It was not found in the lower horizons of the stage.

Comparisons. See *Myalina? newelli.*

Discussion. Conrad's original definition of *M. chemungensis* was based on specimens from the Chemung stage at Narrow Hill (locality 22 of this report), but all later interpretations of the species are based on the well-preserved material illustrated by Hall (1884c) from the Cassadaga stage of Allegany County, New York. In Hall's final volume the species was not listed from any Chemung stage locality. The Elmira area specimens were referred to another species, *M. carinata,* which was described as differing from *M. chemungensis* only in subjective features of shape. The Chemung material described here and the enormous shape variability in populations of living mytilids make it certain that these two Chemung species are subjective synonyms. The Cassadaga stage specimens illustrated by Hall also appear to fall within the range of variation of the Chemung ma-

terial but, should future work prove these younger specimens to be distinguishable, then a new species name will be required for them. The species *M. attenuata* is based on a single specimen from a glacial boulder found in the Elmira region which is probably a somewhat compressed specimen of *M. chemungensis*.

Genus MYALINA

Author. Koninck, 1842, p. 125.

Type species. *Myalina goldfussiana* Koninck (1842, p. 126) by subsequent designation of Stoliczka, 1871, p. 366 (see Newell, 1942, p. 45).

Discussion. The genus name is used here provisionally for the distinctive anteriorly-lobed Chemung species described below. This is apparently the first reference of a North American Upper Devonian species to this genus. The ligament and shell structure of the Chemung species are unknown, and the generic assignment is therefore tentative, being based solely on shape.

Admirable reviews of this genus and related genera of post-Mississippian mytiloid pelecypods have been given by Newell (1942). In the pre-Mississippian mytiloids the usual generic chaos prevails. Important discussions of these earlier forms include those of Frech (1891), Isberg (1934), and Maillieux (1937).

Myalina? newelli, n. sp.

(Plate 16, figures 2-5)

Description. Shell of medium size (median length of 7 specimens 20 mm), probably equivalve (right valve poorly known), moderately inflated. Shape extremely variable, height varying from 71 to 134 percent of length. Margins variable but prominent anterior lobe present in all specimens. Umbones small, sub-anterior in position. Surface sculpture of fine to coarse, irregularly spaced, concentric ridges and furrows present in well-preserved composite molds, fine ridges becoming more prominent on anterior lobe (pl. 16, fig. 2). Hinge area and dentition unknown. Ligament unknown. Musculature and interior features unknown. Shell material unknown.

Types. Holotype: Yale Peabody Museum No. 21493. Type locality: locality 23A described on p. 72 of this report. Stratigraphic position: Upper Devonian, Chemung stage. Additional specimens: Yale Peabody Museum Nos. 21494-21501.

Material. The species is based upon nine specimens, four of which are sufficiently well-preserved for illustration. All of the specimens are permanently deposited in the Yale Peabody Museum.

Occurrence. This rare species is known from three Chemung stage localities, Nos. 23A (3 specimens), 34 (4 specimens), and 53 (2 specimens), these localities representing the lower (34) and middle (53, 23A) beds of the stage.

Comparisons. The species is so distinctive that misidentification is unlikely, although elongate specimens in which the anterior lobe is not preserved could be confused with *Mytilarca chemungensis*.

Discussion. At first glance the holotype (pl. 16, fig. 2) and the posteriorly elongated specimen from locality 53 (pl. 16, fig. 4) appear so dissimilar in shape as to make their specific identity doubtful. The shape of the second specimen from locality 53 (pl. 16, fig. 3), which was found on the same bedding plane as the specimen shown in fig. 4, is more nearly like that of the holotype and confirms the treatment of all the anteriorly-lobed Chemung specimens as a single species of variable outline. The extreme shape variability in populations of living mytiloid pelecypods supports this broad definition of specific limits.

In the absence of knowledge of the ligament area, the species is assigned to the genus *Myalina* only on the basis of shape, and therefore the generic assignment is tentative.

The species is dedicated to Dr. Norman D. Newell of the American Museum of

Natural History and Columbia University in recognition of his exemplary studies of Paleozoic mytiloid pelecypods.

Myalina? sp.

(Plate 16, fig. 6)

Two poorly preserved composite molds of an elongate, anteriorly-lobed mytiloid may belong to this genus. The outline of the valves is almost identical with the Mississippian specimen of *Myalina* illustrated by Newell (1942, pl, 7, fig. 4) as a primitive example of the genus. The specimens were found at localities 66 and 87.

Genus PTYCHODESMA

Author. Hall and Whitfield, 1872, p. 192.

Type species. *Ptychodesma knappianum* Hall and Whitfield (1872, p. 7) by original designation and monotypy.

Discussion. The generic name was proposed for a distinctive Middle Devonian species of sub-circular outline which shows an external chevron-groove type of ligament. Future generic revisions will probably prove this species to be distinctive enough to warrant the generic name.

The genus is apparently very rare and is represented in the North American Middle Devonian by only a few specimens of the type species.

Apart from the Chemung forms discussed below, the only species described from the North American Upper Devonian is Hall's (1885, p. 353) *Ptychodesma nanum* which was based on a few small specimens from the Finger Lakes stage at Ithaca, New York. These specimens are probably correctly assigned to the genus *Ptychodesma*, but the species needs restudy for adequate recognition.

Discussions of the genus are given by Williams and Breger (1916) and Newell (1938).

Ptychodesma neglectum (Hall)

(Plate 16, figures 7-23)

Modiomorpha neglecta Hall, 1883, p. 13, pl. 41, fig. 13 [not fig. 12]. Hall, 1885, p. 290, pl. 41, fig. 13.
Ptychodesma? *minor* Hall, 1883, p. 13, pl. 41, fig. 27.
Ptychodesma minor Hall. Hall, 1885, p. 353, pl. 41, fig. 27.

Revised description based on specimens from Chemung stage. Shell of medium size (median length of 18 specimens 15 mm), equivalve, inequilateral, moderately inflated. Shape variable, height ranging from 65 to 87 percent of length. Umbones small, anterior in position, directed forward, extending to dorsal margin. Surface sculpture of very fine, evenly spaced concentric ridges present on well-preserved composite molds (pl. 16, figs. 11, 12); wider, more irregularly spaced concentric grooves and furrows present on most composite molds (pl. 16, figs. 18, 19, 21). Lunule and escutcheon unknown. Most composite molds show flattened area along posterior part of dorsal margin (pl. 16, figs. 8, 11, 13, 14), possibly impression of edentulous hinge plate or ligament area, dentition and ligament otherwise unknown. Musculature and interior features unknown. Shell material unknown.

Types. Holotype of *Ptychodesma neglectum* (Hall), here designated, the specimen shown by Hall, 1885, as fig. 13 of pl. 41, No. 6136/1 in the American Museum of Natural History, New York, New York, U.S.A. (pl. 16, figs. 7, 8). Type locality: Buck's Quarry [?], near Elmira, New York, U.S.A. Stratigraphic position: Upper Devonian, Chemung stage. Holotype of *Ptychodesma minor* Hall, here designated, the specimen shown by Hall, 1885, as fig. 27 of pl. 41, No. 6133/2 in the American Museum of Natural History, New York, New York, U.S.A. (pl. 16, figs. 9, 10). Type locality: near Elmira, New York, U.S.A. Stratigraphic position: Upper Devonian, probably Chemung stage.

MATERIAL. The revised description was based on 32 specimens from the Chemung stage, all of which are permanently deposited in the Yale Peabody Museum.

OCCURRENCE. This rare species is apparently unknown outside the Chemung stage. Within the stage it was found at seven localities but it was common only at locality 75 (24 specimens), which probably represents a horizon near the middle of the stage. It was not found in the lower horizons of the stage.

COMPARISONS. This is the only Chemung stage species of the genus and thus it is unlikely to be misidentified.

DISCUSSION. Hall based the species on a somewhat distorted specimen from the now lost locality of "Buck's Quarry." The present study turned up 24 similar forms at locality 75 which show that undistorted specimens of "*Modiomorpha*" *neglecta* are almost identical in outline to the Middle Devonian species *Ptychodesma knappianum* which is the type of Hall and Whitfield's genus *Ptychodesma*. No specimens of the rare *P. knappianum* are available to me for comparison, but the types of this species apparently have the shell material preserved and show an external chevron ligament (see Hall, 1885; Kindle, 1900; Williams and Breger, 1916; Newell, 1938). The Chemung specimens are all composite molds which do not preserve the ligament area and therefore the generic assignment is tentative because it is based solely on similarities in shape and sculpture.

Hall described another distorted specimen from "near Elmira" as *Ptychodesma? minor* but this is undoubtedly the same species as *Modiomorpha neglecta*. The name "*neglecta*" has page precedence and is also based on a better specimen. For these reasons it is used here for the combined species.

GENUS GONIOPHORA

AUTHOR. Phillips, 1848, p. 264.

TYPE SPECIES. *Cypricardia cymbaeformis* Sowerby (1839, p. 602, 609) by original designation.

DISCUSSION. Only two species of this distinctive genus, in addition to those treated below, appear to have been described from the Upper Devonian of North America. These are *Goniophora curvata* Simpson (1890, p. 451) and *Goniophora ruedemanni* Caster (1930, p. 78, pl. 25a, figs. 12, 13), both from the Conewango stage of western New York and Pennsylvania. As noted by Caster (1930, p. 78), *G. curvata* probably belongs in the genus *Sphenotus* because of the "ridge along the middle of the umbonal slope." *G. ruedemanni* cannot be recognized as a *Goniophora* from Caster's illustrations.

Several undescribed Conewango stage specimens of the genus are in the collections of the Yale Peabody Museum and so the genus may be expected to occur through the whole of the Appalachian Upper Devonian, although it has not yet been reported from the Cassadaga stage.

A very useful review of the genus up to about 1910 has been given by Williams and Breger (1916). Important later discussions include those of Hind (1910), McLearn (1924), Isberg (1934), and Ruzicka and Prantl (1959).

Goniophora chemungensis (Vanuxem)

(Plate 17, figures 1-11)

Cypricardites chemungensis Vanuxem, 1842, p. 181, p. 179, fig. 2.
Sanguinolites chemungensis (Vanuxem). Miller, 1877, p. 202.
Goniophorus chemungensis (Vanuxem). Bigsby, 1878, p. 70.
Goniophora chemungensis (Vanuxem). Hall, 1883, p. 13, pl. 44, figs. 18-22. Hall, 1885, p. 303, pl. 44, figs. 18, 20, 22. [not] Willard, 1939, pl. 25, fig. 27.
[?] *Cypricardites carinata* Conrad, 1841, p. 53. [later references omitted, this is *Goniophora carinata* of Hall, 1885].
[?] *Goniophora trigona* Hall, 1885, p. 302, pl. 42, fig. 12, pl. 44, fig. 9 [later references omitted].
[?] *Goniophora subrecta* Hall, 1885, p. 304, pl. 42, figs. 14, 15, pl. 44, figs. 19, 21 [later references omitted].

Revised description based on specimens from Chemung stage. Shell of large size, (median length of 24 specimens 39 mm), equivalve, very inequilateral, moderately inflated. Shape variable, height ranging from 30 to 59 percent of length. Strong carina extending from umbo to posterior ventral extremity. Ventral margin slightly indented near anterior end, causing an obscure groove which extends obliquely across shell from umbo to ventral margin. Umbones anterior, directed forward, extending to or very slightly above dorsal margin; distance from umbo to anterior extremity variable. Surface sculpture of coarse to fine, irregularly spaced concentric ridges and furrows; additional ridges are added below the umbo and anterior to the obscure radial groove. Sculpture more prominent on anterior part of valve. Lunule and escutcheon unknown. Hinge and dentition unknown. Ligament unknown. Musculature and interior features unknown. Shell material unknown.

Types. Holotype of *Goniophora chemungensis* (Vanuxem), here designated, the specimen shown by Vanuxem, 1842, as fig. 2, p. 179, and by Hall, 1885, as fig. 18 of pl. 44, No. 2407 in the New York State Museum, Albany, New York, U.S.A. (pl. 17, figs. 1, 2). Type locality: Owego, New York, U.S.A. Stratigraphic position: Upper Devonian, Chemung stage.

Material. The revised description was based on 31 specimens from the Chemung stage, all of which are permanently deposited in the Yale Peabody Museum.

Occurrence. The species is known with certainty only from the Finger Lakes and Chemung stages of eastern and east-central New York. Within the Chemung stage the species is common only at locality 38. It is occasional at two nearby localities (30, 33) and rare in the higher and more westerly beds of the stage.

Comparisons. The extended anterior and lack of a prominent escutcheon serve to distinguish small specimens from *G. cayutensis*.

Discussion. The 18 specimens from locality 38 show great shape variability (pl. 17, figs. 4-9) and indicate that a wide latitude of variability must be allowed in defining species of *Goniophora*. Most of these specimens were found on a single bedding plane.

Three species (*G. carinata, trigona,* and *subrecta*) based on Finger Lakes stage specimens from east-central New York appear to fall within the range of variation shown by the Chemung specimens, but pending restudy they are treated here as questioned synonyms.

Goniophora cayutensis, n. sp.

(Plate 18, figures 1, 2)

Description. Shell of medium size (length of holotype 26 mm), equivalve (differences in valve shapes of holotype probably caused by distortion), very inequilateral and elongate, strongly inflated. Height about one half of length. Strong carina extending posteriorly from umbo. Posterior-ventral extremity unknown (missing from holotype). Umbones anterior, directed forward, small, extending well above dorsal margin. Surface sculpture of fine concentric ridges prominent anteriorly, obscure on umbones, becoming finer posteriorly and indistinct behind carina. Lunule unknown. Escutcheon prominent and wide (1 mm on holotype). Hinge and dentition unknown. Ligament unknown. Musculature and interior features unknown. Shell material unknown.

Types. Holotype: Yale Peabody Museum No. 21525. Type locality: locality 65, described on p. 73 of this report. Stratigraphic position: Upper Devonian, Chemung stage. Additional specimen: Yale Peabody Museum No. 21526.

Material. The species is known only from the holotype, a free specimen from locality 65 preserving both valves in articulation, and a single additional fragment from locality 87 which is too poorly preserved to be figured. These specimens are permanently deposited in the Yale Peabody Museum.

Occurrence. Known only from two Chemung stage localities, locality 65 (type locality) and locality 87.

Comparisons. The species is distinguished from *G. chemungensis* by the elongate shape, prominent escutcheon, and the extreme anterior position of the umbones.

Discussion. This form is so unlike any *Goniophora* known to me that a new specific name seems desirable, even though based on only three valves. Future generic revision may even show the species to belong in some other genus, but for the present I know of no more appropriate generic assignment.

The specific name is taken from Cayuta Creek, the type locality.

Goniophora sp.

(Plate 18, figure 3)

Seven poorly preserved specimens of a small *Goniophora* were collected from localities 22 (1 specimen), 66 (3 specimens), and 23B (3 specimens). The specimens have more rounded anterior extremities and more forwardly placed umbones than *G. chemungensis* and are proportionately much higher than *G. cayutensis*. In addition, they differ from both of these species in having a groove-like indentation on the anterior surface similar to that shown in Hall's Finger Lakes stage species *Goniophora minor* (1885, pl. 42, figs. 4-6), which these specimens closely resemble. Pending restudy of *G. minor*, no name will be given to these poorly preserved Chemung stage specimens.

Genus MODIOMORPHA

Author. Hall and Whitfield, 1869, p. 72.

Type species. *Pterinea concentrica* Conrad (1838, p. 116) by informal original designation and subsequent designation of Hall, 1885, p. xxiii.

Discussion. This distinctive and widely distributed Devonian genus is represented in the North American Upper Devonian by five previously described occurrences (excluding *M. neglecta* which is here assigned to the genus *Ptychodesma*). These are:

1. The specimens from the Finger Lakes stage at Ithaca and Cortland, New York, described by Hall (1885, p. 284) as *Modiomorpha subalata* var. *chemungensis*. These specimens are almost certainly conspecific with the well-known Middle Devonian species *Modiomorpha subalata*, but restudy will be necessary to prove the usefulness of the infraspecific name.

2. The three specimens from the Cassadaga stage at Mansfield, Tioga County, Pennsylvania, described by Hall (1885, p. 287, 291) as *Modiomorpha tioga* and *Modiomorpha subangulata*. As noted below, *M. tioga* is doubtfully distinguishable from *M. mytiloides*. *M. subangulata* needs restudy but is probably a valid species. It has been reported from the "Chemung" of Maryland by Clarke and Swartz (1913, p. 650) but the identification is doubtful.

3. The Cassadaga stage specimens from Allegany County, New York, described by Hall (1885, p. 287-289) as *Modiomorpha quadrula*, *M. rigida*, and *M. recurva*. All these "species" are of doubtful generic affinities and all will require restudy for adequate recognition.

4. The specimens from Tioga County, Pennsylvania, described by Simpson (1890, p. 449) as *Modiomorpha rigidula*. Simpson's illustration cannot be recognized as a *Modiomorpha*.

5. The well-preserved specimens from the Upper Devonian Snyder Creek shale of Missouri described by Branson (1922, p. 114) as *Modiomorpha missouriensis*. These specimens probably should not be assigned to the genus *Modiomorpha* but may belong in either *Ptychodesma* or *Paracyclas*.

Hence the genus is known with certainty from the North American Upper Devonian only in the Appalachian region where it is of occasional occurrence throughout the Finger Lakes, Chemung, and Cassadaga stages. It is as yet unknown from the Conewango stage.

Important discussions of the genus are given by Beushausen (1895) and Williams and Breger (1916).

Modiomorpha mytiloides (Conrad)

(Plate 19, figures 14-16)

Cypricardites mytiloides Conrad, 1841, p. 52.
Modiomorpha mytiloides (Conrad). Hall, 1885, p. 277, pl. 37, fig. 3, pl. 38, figs. 1-16. Nettelroth, 1889, p. 220. Cleland, 1911, p. 114, pl. 23, fig. 4. [?] Prosser and Kindle, 1913, p. 269, pl. 33, fig. 7. [?] Willard, 1939, pl. 25, fig. 30.
Modiomorpha mytiloides milwaukeensis Pohl, 1929, p. 68, pl. 12, figs. 4, 5.
Modiomorpha planulata Hall and Whitfield, 1869, p. 74.
Modiomorpha complanata Hall and Whitfield [in part]. Hall, 1883, p. 12, pl. 38, figs. 1-16.
[?] *Cypricardites alta* Conrad, 1841, p. 52 [later references omitted, this is *Modiomorpha alta* of Hall, 1885, and later authors].
[?] *Modiomorpha macilenta* Hall and Whitfield, 1869, p. 76 [later references omitted].
[?] *Modiomorpha tioga* Hall, 1885, p. 291, pl. 40, fig. 18 [later references omitted].

Revised description based on specimens from Chemung stage. Shell of large size, (median length of 4 specimens 60 mm), equivalve, inequilateral, inflated. Shape variable, height ranging from 58 to 85 percent of length. Umbones prominent, anterior, directed forward, extending above dorsal margin. Surface sculpture of fine to coarse, irregularly spaced, discontinuous concentric ridges and furrows present on well-preserved composite molds. Lunule and escutcheon unknown. Hinge and dentition unknown. Ligament unknown. Interior features unknown. Shell material unknown.

Types. Conrad's original description was unaccompanied by illustrations and his types are probably lost, although they may be as yet unrecognized among the various Hall collections. Hall and Whitfield (1869) apparently proposed the new name *Modiomorpha planulata* for this species before realizing that Conrad's earlier name had priority. In the final report, Hall (1885) merely lists *M. planulata* as a synonym of *M. mytiloides* (Conrad). Since no figures accompanied Hall and Whitfield's original description of *Modiomorpha planulata*, no meaningful holotype can be designated for the species name.

Material. The revised description was based on five specimens from the Chemung stage, all of which are permanently deposited in the Yale Peabody Museum.

Occurrence. This is apparently the first definite report of this common New York Middle Devonian species from the North American Upper Devonian, although another occurrence may be represented by the doubtfully identified Upper Devonian specimen figured by Willard (1939, pl. 25, fig. 30).

Within the Chemung stage the species is quite rare, being known only from five large specimens from locality 66.

Comparisons. This is the only Chemung stage representative of the genus and so it is unlikely to be misidentified.

Discussion. In his final description of *Modiomorpha macilenta*, Hall (1885, p. 280) states: "The typical forms here recorded under the specific designations of *M. mytiloides*, *M. alta*, and *M. macilenta*, are easily distinguishable; but in the study of large collections we find so many intermediate forms that it becomes difficult, if not impracticable, to arrange them under these several designations." There is little doubt that future revision of the New York Middle Devonian pelecypods will show these names to be synonyms, but they are questioned in the above synonymy on the chance that they might prove useful for population-defined Middle Devonian species.

Hall's Cassadaga stage specimen described as *Modiomorpha tioga* will also probably prove indistinguishable from *M. mytiloides*.

Genus GLOSSITES

Author. Hall, 1885, p. xlix.

Type species. *Glossites lingualis* Hall (1885, p. 496) by original designation.

Discussion. The peculiar flattened and posteriorly elongated Upper Devonian specimens for which Hall founded the genus *Glossites* are probably distinctive enough to

warrant the generic name, although the preservation of most specimens is very poor, judging from the Chemung stage material.

The only species known from the North American Upper Devonian is *Glossites depressus* (including suggested synonyms) which is described below (see the discussion of *G. depressus*).

The genus is discussed by Beushausen (1895) and Williams and Breger (1916).

Glossites depressus Hall

(Plate 18, figures 4-13)

Glossites depressus Hall, 1885, p. 496, pl. 40, figs. 15, 17, pl. 96, fig. 12.
Modiomorpha? amygdalina (Winchell) [in part]. Hall and Whitfield, 1869, p. 78. [in part] Hall, 1883, p. 12, pl. 40, figs. 15, 17.
[?] *Glossites lingualis* Hall, 1885, p. 497, pl. 40, figs. 16, 19, pl. 96, figs. 9-11 [later references omitted].
[?] *Glossites ellipticus* Hall, 1885, p. 498, pl. 96, fig. 8 [later references omitted].
[?] *Glossites rudicula* Hall, 1885, p. 498, pl. 96, fig. 17 [later references omitted].
[?] *Glossites procerus* Hall, 1885, p. 499, pl. 96, fig. 13 [later references omitted].
[?] *Glossites subnasutus* Hall, 1885, p. 500, pl. 96, fig. 14 [later references omitted].
[?] *Glossites patulus* Hall, 1885, p. 501, pl. 96, figs. 15, 16 [later references omitted].

Revised description based on specimens from Chemung stage. Shell of large size (median length of 7 specimens 48 mm), equivalve, inequilateral, flattened. Shape variable, height ranging from 46 to 68 percent of length. Umbones small, depressed, directed forward, in extreme anterior position, not extending above dorsal margin. Surface sculpture of broad, irregularly spaced concentric ridges and furrows present in most composite molds. Lunule and escutcheon unknown. Hinge plate probably represented on most composite molds as flattened area along dorsal margin (pl. 18, figs. 5-9, 12, 13); hinge and dentition otherwise unknown. Internal ligament groove possibly obscurely represented in a single composite mold as short groove above umbo (pl. 18, fig. 13), ligament otherwise unknown. Small, elongate, anterior adductor scar in extreme anterior position obscurely represented on several composite molds (pl. 18, figs. 6, 13), other interior features unknown. Shell material unknown.

Types. Holotype of *Glossites depressus* Hall, here designated, the specimen shown by Hall, 1885, as fig. 17 of pl. 40 and fig. 12 of pl. 96, No. 6178/1 in the American Museum of Natural History, New York, New York, U.S.A. (pl. 18, figs. 4, 5). Type locality: Buck's Quarry[?], near Elmira, New York, U.S.A. Stratigraphic position: Upper Devonian, Chemung stage.

Material. The revised description was based on 11 specimens from the Chemung stage. Of these, 9 are permanently deposited in the Yale Peabody Museum and the other 2 are from the Hall collections at the New York State Museum and American Museum of Natural History (see figured specimens).

Occurrence. The species is rare in the Chemung stage and is relatively common only at locality 66 (seven specimens), with single specimens coming from localities 22 and 96. Localities 66 and 22 are both probably near the stratigraphic middle of the stage, whereas locality 96 represents a lower horizon.

The species is apparently more abundant in the Cassadaga stage where it is represented by many specimens described by Hall (1885) as *Glossites lingualis, ellipticus, rudicula, procerus, subnasutus,* and *patulus.* Hall also cites a figured specimen (1885, pl. 40, fig. 15) as coming from Ithaca, New York (Finger Lakes stage), but this is apparently a mistake, the specimen (which is figured here as pl. 18, fig. 12) being labeled "Elmira, New York." No undoubted pre-Chemung occurrences are known to me, but this may be a result of inadequate collecting. A specimen probably representing this species is figured by Kindle (1909, pl. 10, fig. 1) from the Upper Devonian Ouray limestone of Colorado.

Comparisons. The only Chemung stage species with which *G. depressus* is likely to be confused is *Spathella typica* from which it differs in being much less inflated, typically

higher in proportion to the length, having less prominent concentric sculpture, and in having the characteristic flattened hinge plate impression.

Discussion. While it appears likely that all of Hall's Upper Devonian species of *Glossites* are indistinguishable, no definite synonymy will be given here pending a restudy of the more abundant post-Chemung specimens. The Chemung stage species *G. depressus* was the first of the Upper Devonian species described by Hall in the 1885 report, but should restudy prove it to be indistinguishable from the Cassadaga forms, the name *G. lingualis* should probably be used for the combined species. This would permit the species to be founded on the more abundant post-Chemung material and would avoid generic-level confusion resulting from Hall's designation of *G. lingualis* as the type of the genus.

Genus SPATHELLA

Author. Hall, 1885, p. xxxiii.

Type species. *Spathella typica* Hall (1885, p. 407), by original designation.

Discussion. Hall proposed the genus *Spathella* for elongate, cylindrical, Chemung stage specimens which are very similar to the recent rock-boring genus *Lithophaga* Bolten, 1798 (=*Lithodomus* Cuvier, 1817). Related forms are sparingly found in many post-Devonian pelecypod faunas, but most authors have assigned even the Carboniferous and Permian species to the recent genus *Lithophaga* (see, for example, Hind, 1896, p. 73[1], Newell, 1942, p. 43, and Newell, 1955, p. 27). I regard it as generally undesirable to use recent generic names for Paleozoic pelecypods and so Hall's name will be retained here because it is apparently the only generic name proposed for Paleozoic species of "*Lithophaga*."

The only species of the genus known from the North American Upper Devonian is the type species, *Spathella typica*, which is described below.

The only discussions of the genus since its proposal appear to be those of Whidborne (1897) and Hind (1904).

Spathella typica Hall

(Plate 19, figures 1-13)

Spathella typica Hall, 1885, p. 407, pl. 66, figs. 36, 37, 39, 40, [?] fig. 38. [?] Willard, 1939, pl. 27, fig. 12.

Sanguinolites ventricosus (White and Whitfield) [in part]. Hall, 1883, p. 16, pl. 66, figs. 36, 37, 39, 40, [?] fig. 38.

Revised description based on specimens from Chemung stage. Shell of large size (median length of 19 specimens 32 mm), equivalve, inequilateral, extremely elongate posteriorly, strongly inflated. Shape variable, height ranging from 36 to 59 percent of length. Umbones small, anterior, directed forward, extending to or slightly above dorsal margin. Surface sculpture of very fine, evenly spaced concentric ridges present on well-preserved composite molds (pl. 19, fig. 13), becoming fainter and more widely spaced posteriorly. Most composite molds also show coarser and much more widely spaced concentric ridges and furrows. Lunule and escutcheon unknown. Hinge characters and dentition unknown. Ligament unknown. Musculature and interior features unknown. Shell material unknown.

Types. Holotype of *Spathella typica* Hall, here designated, the specimen shown by Hall, 1885, as fig. 37 of pl. 66, No. 6177/1:1 in the American Museum of Natural History, New York, New York, U.S.A. (pl. 19, figs. 1, 2). Type locality: Chemung

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[1] Note that Hind recognized the genus *Spathella* (1904, p. 153) but misidentified it, his species of the genus not being congeneric with *S. typica*. Species of typical *Spathella* were described by Hind as *Lithodomus*.

County, New York, U.S.A. Stratigraphic position: Upper Devonian, probably Chemung stage.

Material. The revised description was based on 25 specimens from the Chemung stage, all of which are permanently deposited in the Yale Peabody Museum.

Occurrence. This rare species is known outside the Chemung stage only from the single specimen from Ithaca, New York (Finger Lakes stage), figured by Hall (1885, pl. 66, fig. 36, locality from Clarke and Ruedemann, 1903, p. 514). Within the Chemung stage the species was found sparingly at ten localities representing all generalized stratigraphic horizons.

Comparisons. See *Glossites depressus*.

Discussion. Hall's five figured specimens were merely cited as coming from Tompkins and Chemung Counties, New York. Whitfield and Hovey (1898, p. 307) give the localities of three of the figured specimens (pl. 66, figs. 37, 39, 40) as "Chemung County" and a fourth (pl. 66, fig. 38) as "Tompkins County." The exact locality of these specimens is unknown. Hall's fifth and final figured specimen (pl. 66, fig. 36) is listed by Clarke and Ruedemann (1903, p. 514) as coming from Ithaca, New York, and this specimen records the only certain record of the species outside the Chemung stage.

The species is very similar to post-Devonian specimens which are usually assigned to either *Sanguinolites* M'Coy, 1844, or *Lithophaga* Bolten, 1798. Future species-level revisions may show the Devonian name to be a synonym of some previously described post-Devonian species, but for the present Hall's species name will be retained for the Chemung specimens.

Genus PSEUDAVICULOPECTEN

Author. Newell, 1938, p. 38.

Type species. *Monotis princeps* Conrad (1838, p. 117, =*Aviculopecten princeps* of later authors) by original designation.

Discussion. Most Devonian pectinoid pelecypods have traditionally been assigned to one of three genera: *Aviculopecten* M'Coy (1851, p. 171), *Lyriopecten* Hall (in Miller, 1877, p. 193), and *Pterinopecten* Hall (1883, p. 3).[1]

Newell has shown in his monumental revision of North American Pennsylvanian and Permian pectinoids (Newell, 1938) that the Carboniferous type species of *Aviculopecten* probably lacks the external chevron ligament grooves found in many Devonian species of "*Aviculopecten*." For this reason Newell erects the new genus *Pseudaviculopecten* for the Devonian forms, choosing as the type the well-known Middle Devonian species *Aviculopecten princeps* (Conrad) which is known to have the characteristic chevron ligament. Most specimens of Devonian "*Aviculopecten*" are preserved as composite molds which rarely show the nature of the ligament, and hence an unequivocal generic assignment is usually impossible. On historical grounds, however, it seems likely that most Devonian species of "*Aviculopecten*" had the chevron ligament and consequently the name *Pseudaviculopecten* will be used here for typical "*Aviculopecten*," even when there is no knowledge of the type of ligament.

Hall erected the genera *Lyriopecten* and *Pterinopecten* for species formerly assigned to *Aviculopecten*, but the new names were proposed without adequate definition. *Lyriopecten* was stated to differ from *Aviculopecten* in having a "short hinge-line and a very small anterior ear" (Hall, 1884c, p. xii) but the hinge of the type species (*L. orbiculatus*) is as long or longer than that of typical species of "*Aviculopecten*" such as *A. princeps*. *Pterinopecten* was apparently supposed to differ from "*Aviculopecten*" in having a long hinge line and poorly defined auricles. A glance at the heterogeneous

[1]Omitting several rare genera such as *Crenipecten* and *Vertumnia*. Note also that *Lyriopecten* and *Pterinopecten* are frequently treated as subgenera of *Aviculopecten* (Frech, 1891; Maillieux, 1937; Dechaseaux, 1952).

assemblage of specimens assigned by Hall to each of these genera quickly points up the inadequacies of these definitions. In both genera a thorough restudy of the type species will be necessary to define the generic limits.

The type of *Lyriopecten* has been shown by Newell (1938, p. 38) to be *Lyriopecten orbiculatus* (Hall), a poorly known species from the Middle Devonian of western New York. I doubt that future studies will show this species to be generically distinct from *Pterinopecten undosus* Hall, the type of the genus *Pterinopecten*, although both genera will be tentatively recognized here following Newell (1938). He considers both genera to be valid, although he does not discuss their differentiating characters. The type species of both *Lyriopecten* and *Pterinopecten* appear to have much less distinct auricles in the left valve than does *P. princeps*, the type of *Pseudaviculopecten*, and this characteristic permits a more consistent differentiation of *Pseudaviculopecten* from the other two genera. Newell's work shows that quite probably both *Lyriopecten* and *Pterinopecten* have the chevron ligament characteristic of *Pseudaviculopecten*.

Hall recognized at least 15 species of "*Aviculopecten*" in the northern Appalachian Upper Devonian, but only two of these species, *A. striatus* and *A. plenus*, were reported from Chemung stage localities. These two species are here considered as probable synonyms and are described more completely below. In addition to these and one new species, the present study has turned up the Middle Devonian species *A. fasciculatus* in the Chemung faunas, which is the first documented Upper Devonian report of the species.

Of Hall's remaining 13 species of Upper Devonian "*Aviculopecten*," seven (*A. rugaestriatus, duplicatus, cancellatus, dolabriformis, squama, convexus,* and *signatus*) are described from the Cassadaga stage in the Belmont, Allegany County region, and restudy will probably prove most or all of these to be synonyms. The Cattaraugus County specimen described as *A. itys* is also doubtfully distinguishable from the above group.

The final five species (*A. aequilateralis, celsus, patulus, ellipticus,* and *tenuis*) probably all come from Conewango stage localities, and all are described from only one or two specimens. Most of these species appear distinctive, but restudy and further collecting will be necessary before they can be satisfactorily recognized.

The Schoharie County "Hamilton Group" specimens described by Hall as *A. formio, A. phorcus,* and *A. idas* may represent occurrences of "*Aviculopecten*" in the lowermost Upper Devonian, but the genus is otherwise unreported from the pre-Chemung Upper Devonian.

Only one North American Upper Devonian species appears to have been described since Hall's report: the single specimen from the Conewango stage near Warren, Pennsylvania, called *A. aequalata* by Simpson (1890, p. 445). The species cannot be recognized without restudy.

Important discussions of the Paleozoic pectinoid genera include those by Frech (1891), Whidborne (1892), Hind (1903), Maillieux (1937), Newell (1938), Ruzicka (1951b) [not seen], and Ruzicka, Prantl, and Pribyl (1959).

Pseudaviculopecten striatus (Hall)

(Plate 20, figures 1-10)

Pecten striatus Hall, 1843, p. 265, p. 264, fig. 7.
Aviculopecten striatus (Hall). Hall, 1883, p. 7, pl. 10, figs. 3, 4. Hall, 1884b, p. 232. Hall, 1884c, p. 22, pl. 10, figs. 3, 4. [?] Caster, 1930, p. 40, pl. 31, figs. 2-5.
Aviculopecten plenus Hall, 1883, p. 10, pl. 24, fig. 3. Hall, 1884b, p. 231. Hall, 1884c, p. 21, pl. 24, fig. 3.

Revised description based on specimens from Chemung stage. Shell of medium size (median length of 7 specimens 17 mm), subequivalve, subequilateral. Left and right valves acline or slightly prosocline, gently convex, other variations in shape unknown.

Anterior and posterior auricles present on both valves. Hinge line shorter than greatest length of valves. Prominent surface sculpture of very fine first and second-order radial ridges present on body and auricles. Finer, irregularly spaced concentric ridges and furrows present on well-preserved composite molds, becoming more prominent on auricles. Dentition and hinge features unknown. Ligament unknown. Musculature and interior features unknown. Shell material unknown.

Types. Holotype of *Pseudaviculopecten striatus* (Hall), here designated, the specimen shown by Hall, 1843, as fig. 7, p. 264, and by Hall, 1884c, as figs. 3 and 4 of pl. 10, No. 6058/1 in the American Museum of Natural History, New York, New York, U.S.A. (pl. 20, figs. 1, 2). Type locality: Painted Post, Steuben County, New York, U.S.A. Stratigraphic position: Upper Devonian, probably Chemung stage. Holotype of *Aviculopecten plenus* Hall, here designated, the specimen shown by Hall, 1883, as fig. 3 of pl. 24, No. 2273 in the New York State Museum, Albany, New York, U.S.A. (pl. 20, fig. 8). Type locality: near Elmira, New York, U.S.A. Stratigraphic position: Upper Devonian, probably Chemung stage.

Material. The revised description was based on ten specimens from the Chemung stage, all of which are permanently deposited in the Yale Peabody Museum.

Occurrence. Hall illustrates only the holotype which came from "Painted Post," but he lists the species as occurring at "Chemung Narrows" (locality 22 of this report) and in "Bradford, Tioga, and Warren Counties, Pennsylvania." All of the Pennsylvania records need confirmation, but some may record post-Chemung occurrences of the species.

Caster (1930, pl. 31) illustrates four Conewango stage specimens which he identifies as *Aviculopecten* cf. *striatus* (Hall), but the species in question cannot be recognized without further study and more adequate illustration. *P. striatus* is therefore known with certainty only from the Chemung stage, although post-Chemung occurrences are probable.

Within the Chemung stage the species was found at four localities representing the middle and upper generalized stratigraphic horizons. Five specimens were found at locality 75 and single specimens were found at localities 22, 23A, and 66.

Comparisons. Within the stage the species is easily recognized by its sub-acline shape, sub-equal auricles, and very fine radial sculpture.

Discussion. The well-preserved Chemung specimen figured by Hall (1884c, pl. 24, fig. 3) as *Aviculopecten plenus* is probably a large individual of *P. striatus*.

Hall mentions a "well-marked" ligament area, but only an obscure groove of doubtful origin is present on the holotype (pl. 20, fig. 2).

Pseudaviculopecten fasciculatus (Hall)

(Plate 20, figures 11-13)

Aviculopecten fasciculatus Hall, 1883, p. 6, pl. 5, figs. 9, 10, 12, 16, 17. Hall, 1884a, pl. 2, fig. 5. Hall, 1884b, p. 224, pl. 2, fig. 5. Hall, 1884c, p. 11, pl. 5, figs. 9-17, pl. 81, figs. 1-4. [?] Nettelroth, 1889, p. 224, pl. 3, fig. 4.
Aviculopecten orestes Hall, 1883, p. 6, pl. 5, fig. 11.
Aviculopecten repletus Hall, 1883, p. 6, pl. 5, figs. 13-15.

Revised description based on specimens from Chemung stage. Shell large (median length of 3 specimens 29 mm), inequivalve, inequilateral. Left valve gently convex, right valve unknown. Left valve prosocline, strongly elongated toward posterior. Small but distinct anterior and posterior auricles in left valve, anterior with pronounced byssal sinus. Hinge line much shorter than greatest length of valve. Surface sculpture of fine radial ridges obscurely preserved in composite molds, sculpture not preserved on auricles. Dentition and hinge features unknown. Ligament unknown. Musculature and interior features unknown. Shell material unknown.

Types. No holotype will be designated from among Hall's many illustrated specimens, because I feel that such designation should await a more detailed study of the Middle Devonian occurrences of the species.

Material. The revised description was based on four specimens from the Chemung stage, all of which are permanently deposited in the Yale Peabody Museum.

Occurrence. The Chemung specimens described here appear to be the first report of this Middle Devonian species from Upper Devonian rocks, although the "Hamilton" specimens reported by Hall from Schoharie County may represent occurrences low in the Upper Devonian. Hall also reports, but does not illustrate, specimens from "boulders of the coarse shales of the Hamilton group at Chemung Narrows, New York." These may have been other Chemung stage specimens of the species.

Within the stage the species was found only at localities 66 and 72, which represent horizons near the middle of the stage.

Comparisons. The fine radial ribs and distinctive shape are easily recognized among Chemung stage pectinoids.

Discussion. The Chemung specimens are tentatively identified with the Middle Devonian *P. fasciculatus* on the basis of general similarity of shape and sculpture. The specimens have a somewhat greater posterior elongation than do most Middle Devonian specimens, but they still appear to fall within the range of variation of the Middle Devonian forms in the Yale Peabody Museum.

Pseudaviculopecten bradfordensis, n. sp.

(Plate 20, figures 14, 15)

Description. Shell large (length of single measurable specimen 45 mm), inequivalve, subequilateral, left and right valves acline, gently convex. Shape variability unknown. Anterior and posterior auricles present on both valves, the anterior being more prominent with deep byssal notch in right valve. Hinge line somewhat shorter than greatest length of valve. Prominent surface sculpture of 35 to 40 broad, flattened, first-order radial ridges on both auricles and body of right and left valves, a few finer second-order ridges being present only on the left valve. The right valve preserves traces of crenulate concentric sculpture (pl. 20, fig. 14). Dentition and hinge features unknown. Ligament unknown. Musculature and interior features unknown. Shell material unknown.

Types. Holotype: Yale Peabody Museum No. 21559. Type locality: locality 96, described on p. 74 of this report. Stratigraphic position: Upper Devonian, Chemung stage. Additional specimen: Yale Peabody Museum No. 21560.

Material. The species is based upon two Chemung stage specimens, both of which are figured. These are permanently deposited in the Yale Peabody Museum.

Occurrence. This very rare species is known only from a single specimen each from localities 66 and 96. The species is unknown outside the Chemung stage.

Comparisons. The prominent, broad, concentric sculpture, large size, and prominent auricles are distinctive. The only remotely similar species appears to be *"Aviculopecten" ellipticus* described by Hall (1883) from a single Conewango stage specimen. This specimen has a shorter hinge than *P. bradfordensis* and lacks the radially sculptured auricles of the Chemung species.

Discussion. The specific name is from Bradford County, Pennsylvania, the county in which the type locality occurs.

Genus LYRIOPECTEN

Author. Hall, in Miller, 1877, p. 193.

Type species. *Avicula orbiculata* Hall (1843, p. 202) by monotypy.

Discussion. The validity of the genus has been treated in the discussion of the genus *Pseudaviculopecten.*

Hall recognized four species of Upper Devonian *Lyriopecten* in addition to the four Chemung species treated below. One of the non-Chemung species, *L. priamus,* is from the Finger Lakes stage at Franklin, Delaware County, and the other three (*L. polydorus, fasciatus,* and *solex*) are based on single specimens from post-Chemung horizons. None of

these species can be adequately recognized without restudy. A fifth and probably valid species, *L. interradiatus,* from the "Hamilton" of Schoharie County, may represent another occurrence of the genus low in the Upper Devonian.

The only North American Upper Devonian species which appears to have been assigned to the genus since Hall's report is the single specimen from the Conewango stage called *L. alternatus* by Simpson (1890, p. 446).

Outside the New York area the genus is represented only by Clarke and Swartz's report of *L. tricostata* from the "Chemung" of Maryland (see below).

Lyriopecten tricostatus (Vanuxem)

(Plate 21, figures 1-8; plate 22, figure 8)

Avicula tricostata Vanuxem, 1842, p. 181, p. 179, fig. 1.

Lyriopecten tricostatus (Vanuxem). Hall, 1883, p. 5, 6, 7, pl. 4, fig. 11, pl. 7, fig. 26, pl. 10, figs. 6-12. Hall, 1884b, p. 252. Hall, 1884c, p. 48, pl. 4, fig. 11, pl. 7, fig. 26, pl. 10, figs. 6-12. Clarke and Swartz, 1913, p. 649, pl. 65, fig. 1.

Lyriopecten cymbalon Hall, 1883, p. 10, pl. 24, fig. 8. Hall, 1884b, p. 251. Hall, 1884c, p. 47, pl. 24, fig. 8.

Revised description based on specimens from Chemung stage. Shell large (median length of 8 specimens 55 mm), probably inequivalve (known only from left valves), equilateral to inequilateral, left valve very slightly convex. Smaller specimens sub-acline, larger specimens prosocline, other variations in shape unknown. Distinct posterior auricle present on well-preserved left valves (pl. 21, fig. 6, pl. 22, fig. 8), anterior auricle absent in left valves. Hinge line shorter than greatest length of valves. Well-preserved composite molds of left valves show distinctive surface sculpture consisting of 15 to 20 strong radial ridges; the interspaces and the ridges themselves are overlaid with a reticulate network of smaller and finer radial and concentric ridges (pl. 21, figs. 2, 3). On most composite molds the fine concentric ridges are not preserved, leaving only the large radial ribs showing several finer radial ribs between them. Dentition and hinge features unknown. External chevron-groove ligament obscurely represented as impression of ligament area in several composite molds (pl. 21, figs. 5, 6). Musculature and interior features unknown. Shell material unknown.

Types. Holotype of *Lyriopecten tricostatus* (Vanuxem), here designated, the specimen shown by Vanuxem, 1842, as fig. 1, p. 179, whereabouts unknown. Type locality: unknown, probably from Broome County or Tioga County, New York, U.S.A. Stratigraphic position: unknown, probably Upper Devonian. Vanuxem's figured specimen may be the specimen figured by Hall (1884c) as fig. 10 of pl. 10, the outline and sculpture being similar but not identical in the two illustrations. Hall's illustration more faithfully represents its characters (see figs. 1 and 2 of pl. 21) and thus it cannot be certainly identified as the subject of Conrad's figure. The fact that the specimen is from Broome County, which is part of the area included in Vanuxem's report, tends to support the identification, as does the fact that no collector or date of collection was listed for the specimen in Clarke and Ruedemann's index (1903, p. 437). This information was most likely unavailable for a specimen collected as early as 1836-1842, when the field work was done for Vanuxem's report. This specimen is No. 2705 in the New York State Museum, Albany, New York, U.S.A. (pl. 21, figs. 1, 2). It is labeled as coming from Barker Station [now Itaska], Broome County, New York, U.S.A. (probably Finger Lakes stage). Holotype of *Lyriopecten cymbalon* Hall, here designated, the specimen shown by Hall, 1883, as fig. 8 of pl. 24, No. 6061/1 in the American Museum of Natural History, New York, New York, U.S.A. (pl. 22, fig. 8). Type locality: from a boulder found near Elmira, New York, U.S.A. Stratigraphic position: unknown.

Material. The revised description was based on about 25 specimens from the Chemung stage. Of these, 13 are permanently deposited in the Yale Peabody Museum, the

others being from the Hall collections at the American Museum of Natural History and the New York State Museum (see figured specimens).

Occurrence. This rare species is represented outside the Chemung stage by Conrad's probable original specimen (see above) and by the single specimen illustrated by Hall (1884c, pl. 4, fig. 11) from Schoharie County. Both of these specimens probably record Finger Lakes stage occurrences. A typical specimen has also been illustrated from the "Chemung" of Maryland by Clarke and Swartz (1913, pl. 65, fig. 1).

Within the Chemung stage fragmentary specimens were found at six localities representing all but the highest generalized stratigraphic horizons. The only well-preserved specimens were found at locality 75. Most of Hall's large illustrated specimens from "Chemung County" and "near Elmira" probably came from the enigmatic "Buck's Quarry" (see Whitfield and Hovey, 1898, p. 287), a locality which is now lost.

Comparisons. The species is readily identified by the distinctive surface sculpture.

Discussion. Hall mentioned and figured a "triangular cartilage pit" (1884c, pl. 10, fig. 6), but this is not present on the specimen.

L. cymbalon is a probable synonym, the species being based on a single specimen from a glacial boulder of unknown origin found in the Elmira area.

Lyriopecten anomiaeformis Hall

(Plate 22, figures 1-7)

Lyriopecten anomiaeformis Hall, 1883, p. 5, 7, pl. 4, fig. 10, pl. 10, fig. 5. Hall, ms. in Miller, 1877, p. 193 [nomen nudem]. Hall, 1884b, p. 255. Hall, 1884c, p. 53, pl. 4, fig. 10, pl. 10, fig. 5, pl. 82, fig. 2.

Revised description based on specimens from Chemung stage. Shell large (median length of 6 specimens 32 mm), inequivalve, equilateral to inequilateral, left valve convex, right valve flat. Larger specimens sub-acline, smaller specimens prosocline, other variations in shape unknown. Auricles indistinct or absent on left valve, prominent anterior auricle with deep byssal notch and less distinct posterior auricle present in right valve. Hinge line shorter than greatest length of valve. Surface sculpture of prominent first-order radial ridges and finer second-order ridges in left valve. Right valve with single set of fine radial ridges except on anterior auricle which shows only strong growth lines. Posterior auricle of right valve has fine concentric ridges giving reticulate sculpture pattern. Dentition and hinge features unknown. External chevron-groove ligament obscurely represented as impression of ligament area in a single right valve (pl. 22, fig. 5). Musculature and interior features unknown. Fragments of much-altered, structureless shell material preserved in one specimen (pl. 22, fig. 3), shell material otherwise unknown.

Types. Holotype of *Lyriopecten anomiaeformis* Hall, here designated, the specimen shown by Hall, 1884c, as fig. 5 of pl. 10 and fig. 2 of pl. 82, No. 6060/1 in the American Museum of Natural History, New York, New York, U.S.A. (pl. 22, figs. 1, 2). Type locality: Chemung Creek, New York, U.S.A. [probably locality 22 of this report]. Stratigraphic position: Upper Devonian, Chemung stage.

Material. The revised description was based on nine specimens from the Chemung stage. Of these, seven are permanently deposited in the Yale Peabody Museum, the other two being from the Hall collections at the American Museum of Natural History (see figured specimens).

Occurrence. This very rare species is known only from the Chemung stage. It was found at five localities representing the lower and middle horizons of the stage. The two specimens originally described by Hall probably came from Narrow Hill (locality 22 of this report), but no additional specimens were discovered there during this study.

Comparisons. The distinctive shape and fine, sub-equal radial ribs serve to distinguish this from other species of *Lyriopecten*.

Discussion. This rare species is known only from the two original specimens (one right

and one left valve) and the seven additional specimens (six left valves and one right valve) found during the present study.

Hall mentioned a "cartilage pit," but this is not present on the specimens.

Lyriopecten magnificus Hall

(Plate 23, figure 11)

Lyriopecten magnificus Hall, 1883, p. 6, pl. 8, fig. 8. Hall, 1884a, pl. 2, fig. 12. Hall, 1884b, p. 255, pl. 2, fig. 12. Hall, 1884c, p. 51, pl. 8, fig. 8.
[?] *Lyriopecten macrodontus* Hall, 1883, p. 5, pl. 4, fig. 9, pl. 8, figs. 9, 10 [later references omitted].

Revised description based on specimens from Chemung stage. Shell large (length of single specimen 99 mm), sub-equilateral, slightly prosocline. Left valve flattened, right valve unknown. Variability of shape unknown. Anterior auricle of left valve obscure, posterior auricle distinct. Hinge line much shorter than greatest length of valve. Prominent surface sculpture of about 45 broad, flat, first-order radial ridges with many finer second-order ridges arranged singly in interspaces. Sculpture becoming much finer on posterior auricle of left valve. Very fine, obscure concentric ridges also present. Dentition and hinge features unknown. Ligament unknown. Musculature and interior features unknown. Shell material unknown.

Types. Holotype of *Lyriopecten magnificus* Hall, here designated, the specimen shown by Hall, 1884c, as fig. 8 of pl. 8, No. 2697 in the New York State Museum, Albany, New York, U.S.A. (pl. 23, fig. 11). Type locality: Montrose, Susquehanna County, Pennsylvania, U.S.A. Stratigraphic position: Upper Devonian, probably Chemung stage.

Material. The species is known only from Hall's original specimen, a poorly preserved, predominantly external composite mold (pl. 23, fig. 11) in the Hall collections of the New York State Museum.

Occurrence. This very rare species is known only from Hall's holotype which was found in rocks probably representing the Chemung stage at Montrose, Pennsylvania.

Comparisons. The large size and wide radial ridges are distinctive among Chemung specimens of *Lyriopecten*.

Discussion. Hall (1884c, p. 52) mentioned a "striated" ligament area, but I am unable to see this on the specimen.

The Chemung specimen is doubtfully distinguishable from Hall's Middle Devonian species *L. macrodontus*, but the Upper Devonian name will be retained here pending revision of the Middle Devonian forms.

Genus PTERINOPECTEN

Author. Hall, 1883, p. 3.

Type species. *Pterinopecten undosus* Hall (1883, p. 5) by subsequent designation of Miller, 1889, p. 507.

Discussion. The validity of the genus has been treated in the discussion of the genus *Pseudaviculopecten*.

The genus is sparingly represented throughout the New York Upper Devonian with the possible exception of the Conewango stage. Hall assigned eight Upper Devonian species to the genus, seven of which are treated in the synonymies and discussions of the Chemung species given below. The final species, *P. filitextus*, was described from a glacial boulder found at Pine Valley, Chemung County. No similar forms were found in the present study. The Schoharie County "Hamilton" specimens of *P. vertumnus* illustrated by Hall may record another occurrence of the genus low in the Upper Devonian.

The only North American Upper Devonian species which appears to have been assigned to the genus since Hall's report is the poorly known species *P.? atticus* described by Williams (1887, p. 35) from the "Portage Group" (Finger Lakes stage?) at Attica, New

York. The genus is apparently unknown from the North American Upper Devonian outside the New York area.

Pterinopecten strictus Hall

(Plate 23, figures 1-8)

Pterinopecten strictus Hall, 1883, p. 10, pl. 24, fig. 2.
Pterinopecten (Aviculopecten?) strictus Hall. Hall, 1884b, p. 271. Hall, 1884c, p. 74, pl. 24, fig. 2, pl. 82, fig. 18.
[?] *Pterinopecten imbecilis* Hall, 1883, p. 10, pl. 24, fig. 1 [later references omitted].
[?] *Pterinopecten erectus* Hall, 1884c, p. 77, pl. 82, figs. 15-17 [later references omitted].

Revised description based on specimens from Chemung stage. Shell of medium size (median length of 4 specimens 23 mm), inequilateral, left valve gently convex, right valve flat. Shape variable, height ranging from 81 to 104 percent of length. Left and right valves show distinct anterior auricle, posterior auricle undifferentiated, right valve with strong byssal notch. Hinge line about equal in length to greatest length of valve. Composite molds show surface sculpture of fine first and second-order radial ridges and finer, indistinct concentric ridges giving faint reticulate pattern on both body and auricles. Wider, irregularly spaced concentric furrows also present. Dentition and hinge features unknown. Ligament unknown. Musculature and interior features unknown. Shell material unknown.

Types. Holotype of *Pterinopecten strictus* Hall, here designated, the specimen shown by Hall, 1884c, as fig. 18 of pl. 82, No. 3082 in the New York State Museum, Albany, New York, U.S.A. (pl. 23, figs. 1, 3, 4). Type locality: near Elmira, New York, U.S.A. Stratigraphic position: Upper Devonian, probably Chemung stage.

Material. The revised description was based on eight specimens from the Chemung stage. Of these, six are permanently deposited in the Yale Peabody Museum, the other two being from the Hall collections at the New York State Museum (see figured specimens).

Occurrence. The species is very rare in the Chemung stage, being found at only three localities (21, 75, 103) representing the lower and middle horizons of the stage. Occurrences of this species in the Finger Lakes and Cassadaga stages may be represented by Hall's specimens of *"P. imbecilis"* and *"P. erectus."*

Comparisons. The species differs from *P. suborbicularis* in having much finer radial sculpture and stronger concentric sculpture. It is also more prosocline in shape.

Discussion. The few known Chemung specimens do not permit an adequate knowledge of the variability and true limits of the species, but from published evidence it appears doubtful that Hall's two species, *P. imbecilis* from the Cassadaga stage and *P. erectus* from the Finger Lakes stage, are distinguishable from the Chemung forms. For this reason these species are treated here as questioned synonyms.

The Chemung specimens are doubtfully distinguishable from New York Middle Devonian species of *Pterinopecten,* but a separate name will be retained here pending revision of the Middle Devonian forms.

Pterinopecten suborbicularis (Hall)

(Plate 23, figures 9, 10)

Pterinea? suborbicularis Hall, 1843, p. 264, fig. 1.
Pterinopecten suborbicularis (Hall). Hall, 1883, p. 6, 10, pl. 8, figs. 1, 2, pl. 24, fig. 10. Hall, 1884b, p. 276. Hall, 1884c, p. 80, pl. 8, figs. 1, 2, pl. 24, fig. 10, pl. 82, fig. 4.
[?] *Pterinopecten crenulatus* Hall, 1883, p. 6, pl. 8, figs. 3, 4 [later references omitted, this is *P. crenicostatus* of Hall, 1884c].
[?] *Pterinopecten neptunus* Hall, 1883, p. 6, pl. 8, figs. 5-7 [later references omitted].
[?] *Pterinopecten dispandus* Hall, 1884c, p. 76, pl. 82, figs. 11, 12 [later references omitted].

Revised description based on specimens from Chemung stage. Shell of medium size (median length of 3 specimens 21 mm), slightly inequilateral, left valve sub-acline and gently convex, right valve unknown. Variations in shape unknown. Left valve shows distinct anterior auricle, posterior auricle poorly differentiated. Hinge line slightly shorter than greatest length of valve. Surface sculpture of sharp, prominent, crenulate (in well-preserved composite molds), first and second-order radial ridges on body and ear. Concentric sculpture faint and obscure. Dentition and hinge features unknown. Ligament unknown. Musculature and interior features unknown. Shell material unknown.

Types. No holotype will be designated pending a restudy of the post-Chemung occurrences of the species.

Material. The revised description was based on three specimens from the Chemung stage, all of which are permanently deposited in the Yale Peabody Museum.

Occurrence. The species was described from the Cassadaga stage of Allegany County where it appears to be of common occurrence. The two figured specimens (pl. 23, figs. 9, 10) are from the highest beds of the Chemung stage at locality 76. One additional specimen was found at locality 22. These are the only pre-Cassadaga specimens known.

Comparisons. See *Pterinopecten strictus.*

Discussion. The Chemung specimens are almost certainly conspecific with the variable Cassadaga stage material described by Hall as *P. suborbicularis, P. neptunus,* and *P. crenicostatus.* Most of Hall's figured specimens of these species came from the Belmont (Allegany County) area, and it is doubtful that the three species will prove distinguishable. The Mansfield, Pennsylvania, Cassadaga stage specimens described by Hall as *P. dispandus* are also doubtfully distinctive.

The generic assignment of the species is completely arbitrary, as it resembles about equally the published figures of the type species of both *Pterinopecten* and *Lyriopecten.*

Genus VERTUMNIA

Author. Hall, 1884c, p. xii.

Type species. *Pterinea reversa* Hall (1883, p. 10) by subsequent designation of Whitfield and Hovey, 1898, p. 308.

Discussion. The genus is unique in having a strongly convex right valve and a flattened or concave left valve, characters by which it is readily recognized.

Although originally described by Hall as a subgenus of the pterioid genus *Pterinea, Vertumnia* has been considered by later authors (Pohl, 1929; Newell, 1938) as a pectinoid genus closely related to *Pterinopecten* Hall, and it is so treated here.

The genus is apparently very rare, and is known from the North American Upper Devonian only by the few Chemung stage specimens of the type species discussed below and by a single poorly known Finger Lakes stage species, *V. reproba* Hall (1884c, p. 106), which needs restudy. The genus is somewhat more common in the Middle Devonian of Wisconsin (see Pohl, 1929).

The only discussions of the genus since its proposal appear to be those of Pohl (1929) and Newell (1938).

Vertumnia reversa (Hall)

(Plate 24, figures 1-7)

Pterinea reversa Hall, 1883, p. 10, pl. 24, figs. 6, 12.
Pterinea (*Vertumnia*) *reversa* Hall. Hall, 1884b, p. 294. Hall, 1884c, p. 104, pl. 24, figs. 6, 12, pl. 84, fig. 24.
Vertumnia reversa (Hall). Whitfield and Hovey, 1898, p. 308.
Pterinea reversa var. *avis* Hall, 1883, p. 10, pl. 24, figs. 9, 11, 13.
Pterinea (*Vertumnia*) *avis* Hall. Hall, 1884b, p. 294. Hall, 1884c, p. 105, pl. 24, figs. 9, 11, 13.
Vertumnia avis (Hall). Whitfield and Hovey, 1898, p. 308.

Revised description based on specimens from Chemung stage. Shell large (median length of 7 specimens 44 mm), inequivalve, inequilateral, right valve convex, left valve slightly convex in umbonal region, becoming flat or slightly concave marginally. Distinct anterior auricle on both valves, posterior auricle undifferentiated. Shape variable, height ranging from 65 to 102 percent of length. Surface sculpture on body of both valves consisting of prominent, first-order, radial ridges with wide, flat interspaces. Most specimens show a few faint second-order radial ridges. Both radial ridges and interspaces covered by very fine concentric ridges. Sculpture obscure on auricles. Dentition and hinge features unknown. Ligament unknown. Musculature and interior features unknown. Shell material unknown.

Types. Holotype of *Vertumnia reversa* (Hall), here designated, the specimen shown by Hall, 1884c, as fig. 12 of pl. 24, No. 6075/1 in the American Museum of Natural History, New York, New York, U.S.A. (pl. 24, figs. 1, 2). Type locality: Chemung River, Upper Narrows, New York, U.S.A. [locality 22 of this report]. Stratigraphic position: Upper Devonian, Chemung stage. Holotype of *Vertumnia avis* (Hall), here designated, the specimen shown by Hall, 1884c, as fig. 13 of pl. 24, No. 6074/1:1 in the American Museum of Natural History, New York, New York, U.S.A. (pl. 24, fig. 7). Type locality: near Elmira, New York, U.S.A. Stratigraphic position: Upper Devonian, probably Chemung stage.

Material. The revised description was based on about 20 specimens from the Chemung stage. Of these, 13 are permanently deposited in the Yale Peabody Museum, the others being from the Hall collections at the American Museum of Natural History (see figured specimens).

Occurrence. This rare species was found at seven Chemung stage localities representing the middle and upper generalized stratigraphic horizons. Most of the specimens were fragmentary. Only two specimens were found during the present study at Narrow Hill (locality 22), the original type locality.

The only non-Chemung record of the species appears to be the Cassadaga stage specimen from Mansfield, Pennsylvania, illustrated by Hall (1884c, pl. 24, fig. 11) as *"Pterinea avis."*

Comparisons. The species is unlikely to be confused with other Chemung stage pelecypods.

Discussion. In view of the great shape variability in most Devonian anisomyarian pelecypods, there seems to be little doubt that Hall's closely related species *V. reversa* and *V. avis* are indistinguishable, even though individual specimens are too rare to support the conclusion by demonstrated variability.

The holotype of *V. avis* was probably found at the problematic "Buck's Quarry," a locality which is now lost.

Genus GRAMMYSIOIDEA

Author. Williams and Breger, 1916, p. 133.

Type species. *Grammysia (Grammysioidea) princiana* Williams and Breger (1916, p. 136) by original designation.

Discussion. The reasons for raising *Grammysioidea* to generic rank, as well as recommended changes in Williams and Breger's subgeneric concept, are outlined in the discussion of the genus *Grammysia*.

The genus as defined here occurs throughout the northern Appalachian Upper Devonian. It is represented in the Finger Lakes stage by the specimens from Ithaca, New York, called *Grammysia subarcuata* by Hall (1885, pl. 61, figs. 18, 19) and also possibly by some of the Schoharie and Otsego County specimens identified by Hall (1885) as *Grammysia alveata, G. lirata,* and *G. arcuata*. The Maryland specimens from the Woodmont member of the Upper Devonian Jennings formation described by Clarke and Swartz (1913, p. 607, pl. 59, figs. 14, 15) as *Grammysia communis* Hall may also represent a pre-Chemung occurrence of the genus, although radially grooved forms of the *G. subarcuata-communis-hannibalensis* type are unknown in New York before the Chemung

stage. The genus is rare in the Chemung stage, being represented only by the few specimens described below. It is apparently more common in the post-Chemung Upper Devonian where it is represented by such forms as *"Grammysia" communis* Hall, *"Grammysia" undata* Hall, *"Grammysia" duplicata* Hall, and *"Grammysia" hannibalensis* (Shumard), some of which may prove to be synonyms. The genus also occurs in the Cordilleran Upper Devonian as *"Grammysia" minor* Walcott from the Eureka district of Nevada.

Grammysioidea subarcuata (Hall and Whitfield)

(Plate 25, figures 1-7)

Grammysia subarcuata Hall and Whitfield, 1869, p. 61.
Grammysia (Leptodomus?) subarcuata Hall [and Whitfield]. Hall, 1883, p. 15, pl. 61, figs. 10-22.
Grammysia subarcuata Hall [and Whitfield]. Hall, 1885, p. 375, pl. 61, figs. 10-22, pl. 93, fig. 26.
[?] Clarke and Swartz, 1913, p. 606, pl. 59, fig. 13.

Revised description based on specimens from Chemung stage. Shell of medium size (median length of 4 specimens 42 mm), equivalve, inequilateral, strongly inflated. Shape variability unknown, most specimens being badly distorted from compression. Umbones small, highly inflated, and curving inward on well-preserved specimens (pl. 25, fig. 4) but usually flattened by compression (pl. 25, fig. 6). Distinct radial groove from umbo to anterior part of ventral margin. Prominent sculpture of strong, regularly spaced concentric ridges, additional ridges being added behind the radial groove (pl. 25, figs. 1, 2, 5, 7). Lunule large and distinct (pl. 25, fig. 3), escutcheon unknown. Hinge and dentition unknown. Ligament unknown. Musculature and interior features unknown. Shell material unknown.

Types. Holotype of *Grammysioidea subarcuata* (Hall and Whitfield), here designated, the specimen shown by Hall, 1885, as figs. 13 and 14 of pl. 61, No. 6150/3 in the American Museum of Natural History, New York, New York, U.S.A. (pl. 25, figs. 1, 2). Type locality: near Elmira, New York, U.S.A. Stratigraphic position: Upper Devonian, probably Chemung stage.

Material. The revised description was based on about 12 specimens from the Chemung stage. Four of these are permanently deposited in the Yale Peabody Museum, the others being in the Hall collections at the American Museum of Natural History (see figured specimens).

Occurrence. Within the Chemung stage this species is now very rare. I found only two articulated valves (pl. 25, fig. 3) at locality 103 and two fragments at locality 53. Hall (1885) figured six Chemung stage specimens of the species (pl. 61, figs. 10, 12-17, and 21), five of them from "near Elmira" and the sixth (fig. 12) from "Chemung, New York." Several additional unfigured specimens from "near Elmira" and "Chemung Narrows" are in the Hall collections at the American Museum of Natural History.

Outside the stage the species may be represented in the Finger Lakes and Cassadaga stages by specimens figured by Hall from Ithaca (1885, pl. 61, figs. 18 and 19) and Portville (1885, pl. 61, fig. 11, see Clarke and Ruedemann, 1903, p. 404), but these occurrences need restudy.

Comparisons. This distinctive species is unlikely to be confused with other Chemung stage pelecypods.

Discussion. Most of Hall's specimens are labeled "near Elmira" and these probably came from the now lost "Buck's Quarry" locality, but only one of the specimens (Hall, 1885, pl. 51, fig. 15, here refigured as pl. 25, fig. 5) is so labeled. This would account for the present rarity of the species.

The specimens of this species reported by Clarke and Swartz (1913, p. 606) from the Upper Devonian of Maryland are not figured or described and cannot be recognized without restudy.

Grammysioidea sp.

(Plate 25, figure 8)

A single fragmentary composite mold of an articulated individual which possibly belongs to this genus was found at locality 23A. The specimen lacks the prominent sculpture and radial groove of *G. subarcuata* but is too poorly preserved to warrant a specific name.

Genus GRAMMYSIA

Author. Verneuil, 1847, p. 696.

Type species. *Pterinea bisulcata* Conrad (1838, p. 116) = *Grammysia hamiltonensis* Verneuil (1847, p. 696) by original designation.

Discussion. Williams and Breger (1916, p. 128) gave a detailed and very useful history of this genus and related genera and proposed to restrict the name *Grammysia* to species showing one or two prominent radial grooves ("cinctures"), two such grooves occurring on each valve in *G. bisulcata,* the type species. They then proposed a new subgenus, *Grammysioidea,* for various Devonian species which lack radial grooves but were previously referred to *Grammysia* on the basis of shape and surface sculpture. Still other species referred to *Grammysia* by Hall (1885), but lacking radial grooves, were assigned to the genus *Isoculia* M'Coy (1844). There can be no doubt that Hall's species of *Grammysia* represent several generically distinct groups, but the generic and subgeneric assignments advocated by Williams and Breger appear to be unsatisfactory. Some difficulties which relate to the present study are: (1) the assignment of such apparently closely related forms as *G. subarcuata* and *G. arcuata* to different genera and (2) the unsuitability of the presence or absence of a single radial groove as a subgeneric criterion when samples of one species apparently vary in this feature (see Hall's illustrations of *G. undata,* pl. 6, fig. 23, pl. 64, fig. 30 and pl. 73, fig. 21, also *G. communis,* pl. 61, fig. 24, 25, and *G. hannibalensis,* pl. 61, figs. 29, 30). No meaningful final solution of the generic limits can be arrived at until a restudy of the type species of the many poorly defined genera has been made and type specimens designated and restudied for the species themselves. For purposes of the present study I will, however, propose the following tentative generic limits:

(1) *Grammysia* is restricted to only those forms which show the characteristic double radial grooves of the type species, *G. bisulcata.* Because the true nature of the grooves is often obscured by poor preservation, some individuals of *Grammysia* may be recognizable only by association with more typical forms. This is especially true of the Appalachian Upper Devonian forms which are almost always poorly preserved. The genus as thus restricted includes the following species of Hall (1885, p. 358-383), some of which may prove to be synonyms: *G. bisulcata, nodocostata, magna, erecta, circularis,* and *elliptica.* (2) A separate genus is recommended for the several related grammysioid forms which either lack a radial groove or show a single obscure or prominent radial groove ("cincture"). Such a separation is strengthened by the fact that the Middle Devonian representatives of the group lack the radial groove entirely, as this feature apparently was developed in the early Upper Devonian out of such ungrooved Middle Devonian forms as *G. arcuata* and *G. alveata.* In contrast, the typical doubly grooved *Grammysia* is most abundant in the Middle Devonian, becoming rare in the Late Devonian.

This second group of grammysioids will probably prove to be generically distinct from the type species of closely related genera and will almost certainly include *Grammysia (Grammysioidea) princiana,* which is the type species of Williams and Breger's subgenus *Grammysioidea.* For this reason Williams and Breger's subgenus is raised here to generic rank and tentatively expanded to include not only the non-grooved grammysioid species of the original definition, but related singly grooved species as well. As thus defined, the genus *Grammysioidea* includes the following species of Hall (1885, p. 358-383),

some of which may prove to be synonyms: *"Grammysia" alveata, arcuata, subarcuata, communis, undata, duplicata, hannibalensis,* and *plena.* The other species of *"Grammysia"* described by Hall (1885, p. 358-383), which are not mentioned here as belonging to *Grammysia* or *Grammysioidea,* probably belong in other genera or are too poorly known to warrant positive generic identification.

The genus as thus restricted appears to be known from the Appalachian Upper Devonian only by the single species described below, although Hall's report of several Middle Devonian species *(G. bisulcata, nodocostata, magna, erecta)* from Schoharie County may represent occurrences of species other than *G. elliptica* in the lowest Upper Devonian.

Outside the Appalachian region only two species of *Grammysia* (in its unrestricted sense) appear to have been described from the North American Upper Devonian. These are *G. minor* Walcott (1884, p. 174, pl. 15, figs. 15, 15a) from the Upper Devonian of Nevada, and *G.* (?) *dubia* Fenton and Fenton (1924, p. 174, pl. 23, fig. 10) from the Upper Devonian of Iowa. Of these forms, *G. minor* belongs to the genus *Grammysioidea* as here defined, and *G. dubia* cannot be generically identified without further study.

Grammysia elliptica Hall and Whitfield

(Plate 25, figures 10-12)

Grammysia elliptica Hall and Whitfield, 1869, p. 53.

Grammysia elliptica Hall [and Whitfield]. Hall, 1883, p. 15, pl. 58, figs. 1-12. Hall, 1885, p. 365, pl. 58, figs. 1-12. Lesley, 1889, p. 261. Clarke and Swartz, 1913, p. 606, pl. 59, figs. 11, 12. Branson, 1922, p. 111, pl. 25, figs. 15, 16.

Grammysia chemungensis Pitt, 1873, p. 199, pl. 6.

[?] *Grammysia magna* Hall and Whitfield [in part]. Hall, 1883, pl. 56, fig. 5. [in part] Hall, 1885, pl. 56, fig. 5.

Revised description based on specimens from Chemung stage. Shell large (median length of 3 specimens 58 mm), equivalve, inequilateral, inflated. Shape variability unknown. Umbones large, anterior, directed forward, extended to or slightly above dorsal margin. One distinct radial groove present from umbo to mid-length of ventral margin on left valves, second groove probably present but obscure on specimens. One right valve shows two fine parallel grooves with a wider raised area between. Surface sculpture of coarse, irregularly spaced concentric ridges anterior to radial groove and on dorsal slope. Very fine, commonly obscure concentric sculpture present on well-preserved specimens. Poorly preserved specimens show no surface sculpture (pl. 25, fig. 12). Lunule and escutcheon unknown. Hinge and dentition unknown. Ligament unknown. Anterior adductor scar probably represented by small, rounded, raised area in anterior extremity of one composite mold (pl. 25, fig. 11), other interior features unknown. Shell material unknown.

Types. No holotype will be designated for *G. elliptica* pending restudy of the many post-Chemung specimens of the species. Holotype of *Grammysia chemungensis* Pitt, here designated, the specimen shown by Pitt, 1873, as pl. 6, whereabouts unknown. Type locality: probably Van Campen Creek near Belvidere, Allegany County, New York, U.S.A. Stratigraphic position: Upper Devonian, probably Cassadaga stage.

Material. The revised description was based on six specimens from the Chemung stage, all of which are permanently deposited in the Yale Peabody Museum.

Occurrence. The species probably ranges at least from the lowest Upper Devonian through the Cassadaga stage in New York and Pennsylvania. It is apparently common in the Cassadaga stage, but rare in the Chemung and Finger Lakes stages. The species also probably occurs in the Upper Devonian Snyder Creek Shale of Callaway County, Missouri (Branson, 1922, p. 111). Within the Chemung stage the species is represented by only six specimens from four localities, all representing the lowest beds of the stage. The specimens reported by Hall from Nichols, Tioga County, New York (Hall, 1885, pl. 58, fig. 13) probably came from glacial blocks, and their true stratigraphic position is unknown.

COMPARISONS. This distinctive species is unlikely to be confused with other Chemung stage pelecypods.

DISCUSSION. Pitt's species *Grammysia chemungensis* was apparently based on a misunderstanding of the limits of Hall and Whitfield's species *G. elliptica*. No illustrations of *G. elliptica* had been published when Pitt's name was proposed, and Hall's later illustrations and the probable identity of the type localities make it clear that the two names are synonyms.

The specimen from Ithaca figured by Hall (1885, pl. 56, fig. 5) as *Grammysia magna* probably belongs to this species.

Grammysia sp.

(Plate 25, figure 9)

One well-preserved but incomplete right valve of a small, rounded, *Grammysia* was found in sparingly fossiliferous dark shales at locality 89. The specimen shows the two distinct but shallow radial grooves typical of Upper Devonian representatives of the genus but differs from *G. elliptica* in having a more rounded outline and strong, coarse concentric sculpture over the entire surface. Because *G. elliptica* is known in the Chemung stage from only a few large specimens, it is possible that this specimen merely represents a young individual of *G. elliptica*.

GENUS SPHENOTUS

AUTHOR. Hall, 1885, p. xxxiii.

TYPE SPECIES. *Sanguinolites arcaeformis* Hall and Whitfield (1869, p. 40) by subsequent designation of Miller, 1889, p. 513.

DISCUSSION. Hall's original discussion of this genus was completely unsatisfactory because he mentioned definitive dentition which is not convincingly demonstrated to be present in any of the assigned species, including two species cited as typical examples of the genus, *S. arcaeformis* (Hall and Whitfield) and *S. contractus* (Hall). Williams and Breger noted this problem (1916, p. 127, 235) and concluded that *S. contractus* must be taken as the generic type species because Hall mentions no hinge characters in describing *S. arcaeformis* whereas he describes *S. contractus* as having the cardinal and lateral teeth which presumably characterize the genus. Hall's illustrations of *S. contractus* fail to show such dentition, and it appears likely that most of the specimens which he assigned to the genus *Sphenotus* are edentulous. The situation is further complicated because an earlier and quite valid selection of *S. arcaeformis* as the generic type was made by Miller in 1889, thereby invalidating Williams and Breger's designation of *S. contractus*. A designation of *S. contractus* made by Whitfield and Hovey in 1900 (p. 306) is also invalidated by Miller's designation. To my knowledge there has never been even a reported suspicion of dentition in this species which must be accepted as the generic type. The need for restudy of both species based on large collections is obvious. For the present it appears that the type species *S. arcaeformis* is distinctive enough to warrant generic separation from other Paleozoic edentulous genera, but only species which are obviously congeneric with this Middle Devonian form should be assigned to the genus *Sphenotus* without reservation. The Chemung stage specimens are clearly related to *S. arcaeformis*, and thus the generic name can be applied here with reasonable certainty.

The genus, as defined by Hall, is common in the post-Chemung Upper Devonian of New York where it is represented by many specimens described by Hall as *S. contractus* and *S. clavulus*. The ultimate assignment of these species to the genus *Sphenotus* is, however, doubtful. An earlier Upper Devonian occurrence of the genus may be represented in the Schoharie County specimens described by Hall as *S. cuneatus* and *S. subtortuosus* but these specimens are also doubtfully congeneric with *S. arcaeformis*.

Only one species appears to have been assigned to this genus by the few workers who have described North American Upper Devonian pelecypods since Hall's original descrip-

tion. This is *Sphenotus palmerae* Caster (1930, p. 77, pl. 42, figs. 9, 10) from the Conewango stage of northwestern Pennsylvania. I would tentatively consider this species to belong in the genus *Goniophora,* although Caster's illustrations are inadequate for any final generic determination.

Discussions of the genus are given by Williams and Breger (1916) and Dahmer (1942).

Sphenotus tiogensis, n. sp.

(Plate 26, figures 1-14)

Description. Shell of medium size (median length of 24 specimens 18 mm), equivalve, inequilateral, inflated. Shape variable, height ranging from 36 to 69 percent of length. Umbones anterior, directed forward, extending to or slightly above dorsal margin. Surface sculpture of coarse, irregular concentric ridges most prominent on anterior and ventral portions of valve, becoming obscure on dorsal slope. One specimen (pl. 26, fig. 12) shows obscure radial ridge bisecting dorsal slope, sculpture lacking on dorsal slope in all other specimens. Lunule and escutcheon unknown, probably absent. Hinge characters and dentition unknown. Ligament unknown. Musculature and interior features unknown. Shell material unknown.

Types. Holotype: Yale Peabody Museum No. 21561. Type locality: locality 86, described on p. 73 of this report. Stratigraphic position: Upper Devonian, Chemung stage. Additional specimens: Yale Peabody Museum Nos. 21562-21574, 21659-21703.

Material. The species is based on 58 Chemung stage specimens, all of which are permanently deposited in the Yale Peabody Museum.

Occurrence. The species was found at 14 localities representing all generalized stratigraphic positions within the Chemung stage. It was common only at locality 35 and locality 87, which represent the lowest and highest beds of the stage, respectively. None of the specimens from these two localities was well-preserved enough to serve as holotype, and so a well-preserved specimen from locality 86 was chosen as the holotype. The rocks exposed at locality 86 probably represent a horizon only slightly higher than those at locality 87, where the species is more common.

The species occurs throughout the stage and therefore should be expected in adjacent stages. The only certain non-Chemung specimens are in my own collections from Finger Lakes stage rocks at Kattel Hill, Broome County, New York, where I found the species to be common. The specimen from Smethport, Pennsylvania, illustrated by Hall (1885, pl. 66, fig. 43) as *Sphenotus arcaeformis?* may represent a post-Chemung occurrence of *S. tiogensis.*

Comparisons. The species appears to be most closely related to *Sphenotus arcaeformis* (Hall), the generic type species, which was described from the Middle Devonian of Onondaga County, New York. The Chemung species appears to differ consistently from *S. arcaeformis* only in having coarser concentric sculpture. The Chemung species also appears to show less frequently the variants with a radial ridge or depression bisecting the dorsal slope, although an evaluation of this feature in large suites of *S. arcaeformis* will be needed to confirm this difference.

Discussion. The species *Sphenotus chemungensis* Lesley (1890, p. 990) was based on a specimen form Tioga County, Pennsylvania, and may represent this species, but Lesley's name was published without descriptive definition or indication and consequently is nomenclaturally unavailable.

The specific name is from Tioga County, Pennsylvania, which is the county in which the type locality occurs.

Sphenotus sp.

(Plate 27, figure 1)

Orthonota rigida Hall, 1885, p. 481, pl. 80, fig. 6.
Sanguinolites undatus Hall [in part]. Hall, 1883, p. 19, pl. 80, fig. 6.

The Chemung stage specimen described by Hall (1885, p. 481) as *Orthonota rigida* is probably closely related to *Sphenotus tiogensis* but differs from all known specimens of that species in having a much smaller umbo and a larger dorsal slope with prominent concentric ridges. Hall's specimen is labeled as coming from the now lost "Buck's Quarry" locality, and pending future discoveries it seems prudent to avoid applying a specific name to the specimen.

Types. Holotype of *Orthonota rigida* Hall, here designated, the specimen shown by Hall, 1885, as fig. 6 of pl. 80, No. 6185/1 in the American Museum of Natural History, New York, New York, U.S.A. (pl. 27, fig. 1). Type locality: Buck's Quarry [?], near Elmira, New York, U.S.A. Stratigraphic position: Upper Devonian, probably Chemung stage.

Genus CIMITARIA

Author. Hall and Whitfield, 1869, p. 66.

Type species. *Cypricardites recurva* Conrad (1842, p. 245) by subsequent designation of Hall, 1885, p. xlii.

Discussion. Hall and Whitfield proposed the genus *Cimitaria* for a distinctive scimitar-shaped species from the New York Middle Devonian, but the name has been considered unnecessary by at least two later authors. Beushausen (1895) regarded *Cimitaria* as a synonym of *Leptodomus* M'Coy (1844), whereas Hind (1900) considered it to be a synonym of *Sanguinolites* M'Coy (1844). Pending future revision of these and related genera, Hall and Whitfield's name will be retained here.

The genus is apparently known from the North American Upper Devonian only by the two Chemung stage specimens described below.

Discussions of the genus have been given by Beushausen (1895), Hind (1900), and Williams and Breger (1916).

Cimitaria angulata Hall

(Plate 26, figures 15, 16)

Cimitaria angulata Hall, 1885, p. 468, pl. 77, fig. 15.
Cimitaria recurva (Conrad) [in part]. Hall, 1883, p. 18, pl. 77, fig. 16.

Revised description based on specimens from Chemung stage. Shell large (mean length of two known specimens 80 mm), probably equivalve (right valve unknown), extremely elongate, moderately inflated. Strong carina extending from umbo to posterior ventral extremity. Ventral margin slightly indented near anterior end, causing an obscure groove which extends obliquely across shell from umbo to ventral margin. Variations in shape unknown. Umbones in extreme anterior position, directed forward, extending above dorsal margin. Surface sculpture of obscure concentric ridges and furrows, becoming finer and more regular on dorsal slope. Lunule and escutcheon unknown. Hinge characters and dentition unknown. Ligament unknown. Musculature and interior features unknown. Shell material unknown.

Types. Holotype of *Cimitaria angulata* Hall, here designated, the specimen shown by Hall, 1885, as fig. 15 of pl. 77, No. 2295 in the New York State Museum, Albany, New York, U.S.A. (pl. 26, fig. 16). Type locality: between Elmira and Waverly, Tioga County, New York, U.S.A. [probably locality 66 of this report]. Stratigraphic position: Upper Devonian, Chemung stage.

Material. The species is known only from the holotype and one additional specimen, both of which are in the Hall collections of the New York State Museum.

Occurrence. The two specimens were probably found at locality 66 of this report.

Comparisons. This is the only Chemung stage species of this distinctive genus and therefore it is unlikely to be misidentified.

Discussion. Having found no specimen of *Cimitaria* in my own collecting, I first doubted Hall's description of the Chemung species *C. angulata.* However, after ex-

amining the two specimens on which the species was based, I am convinced that they do represent Chemung occurrences of this Middle Devonian genus because both occur in a typical Chemung matrix and both have the locality data glued to the specimen, making any accidental mislabeling unlikely.

The specimens are doubtfully distinguishable from several Middle Devonian specimens of *Cimitaria* in the Yale Peabody Museum, but Hall's name will be retained for the rare Chemung forms pending a revision of the Middle Devonian species.

Genus EDMONDIA

Author. Koninck, 1844, p. 66.

Type species. *Isocardia unioniformis* Phillips (1836, p. 209) by original designation.

Discussion. The name of this common Carboniferous genus is used here provisionally for finely sculptured, inflated, and probably edentulous pelecypods from the Appalachian Upper Devonian, as no more certain treatment is possible until a restudy is made of the type species of many similar edentulous Paleozoic genera.[1]

The only North American Upper Devonian species, other than those treated below, are Hall's two species *Edmondia tenuistriata* (1885, p. 393) and *Edmondia? subcarinata* (1885, pl. 64, fig. 31). Both of these species are probably incorrectly assigned to the genus *Edmondia*. The specimens of *E. tenuistriata* are recorded as coming from the Elmira area, but the locality is probably in error (see Clarke, 1904, p. 282).

Important discussions of the genus are given by Hind (1899), Girty (1915), and Elias (1957).

Edmondia philipi Hall and Whitfield[2]

(Plate 27, figures 2-21)

Edmondia philipii Hall and Whitfield, 1870, p. 90.

Edmondia philipi Hall [and Whitfield]. Hall, 1883, p. 16, pl. 64, figs. 9-18. Hall, 1884b, pl. 10, figs. 8, 9. Hall, 1885, p. 387, pl. 64, figs. 9, 11-14, 17, 29, pl. 95, figs. 1-4. Lesley, 1889, p. 215. Caster, 1930, p. 79, pl. 36, figs. 4-8.

Edmondia tumidula Hall, 1885, p. 388, pl. 64, figs. 15, 16, 23, pl. 95, figs. 5-8.

Edmondia subovata Hall, 1885, p. 389, pl. 64, figs. 10, 18-21, 26-28, pl. 95, figs. 9-12. Lesley, 1889, p. 215. Butts, 1941, pl. 122, fig. 10.

[?] *Edmondia rhomboidea* Hall, 1883, p. 16, pl. 64, fig. 7, 8 [later references omitted].

[?] *Edmondia transversa* Hall, 1885, p. 389, pl. 64, fig. 24 [later references omitted].

Revised description based on specimens from Chemung stage. Shell of medium size (median length of 41 specimens 18 mm), equivalve, equilateral to inequilateral, moderately to strongly inflated. Shape extremely variable, height ranging from 54 to 100 percent of length, showing obscure tendency toward greater elongation with increase in size (fig. 4). Umbones anterior or central in position, directed forward, small or moderately inflated, extending to or slightly above dorsal margin. Surface sculpture of fine, regularly spaced concentric ridges present on well-preserved predominantly external composite molds (pl. 27, figs. 12, 20). Wide, irregularly spaced concentric furrows present on most composite molds. Lunule and escutcheon unknown. Hinge characters and dentition unknown. Ligament unknown. Musculature and interior features unknown. Shell material unknown.

Types. Holotype of *Edmondia philipi* Hall and Whitfield, here designated, the specimen shown by Hall, 1885, as fig. 14 of pl. 64 and probably also as fig. 1 of pl. 95, No.

[1] In this regard note the apparent similarity between the holotype of *I. unioniformis* as illustrated by Hind (1899, pl. 28, figs. 1, 2) and various North American species referred to the genera *Grammysia* and *Grammysioidea*.

[2] The original spelling "*philipii*" has been universally changed to "*philipi*" by later authors, and this change will be followed here. The variant endings have no nomenclatural significance, the singular being preferred (see Hemming, 1953, p. 54).

6171/1:1 in the American Museum of Natural History, New York, New York, U.S.A. (pl. 27, figs. 2, 3). Type locality: Philipsburgh [now Belmont], Allegany County, New York, U.S.A. Stratigraphic position: Upper Devonian, Cassadaga stage.

Material. The revised description was based on 63 specimens from the Chemung stage, all of which are permanently deposited in the Yale Peabody Museum.

Occurrence. The species, as here defined, is common in the post-Chemung Upper Devonian of New York and northern Pennsylvania, as is indicated by the many specimens illustrated by Hall from Allegany and Cattaraugus Counties, New York, and from Tioga County, Pennsylvania. The specimens described here apparently represent the first documented report of the species from Chemung stage localities, which is surprising in view of its relative abundance. The species is unknown below the Chemung stage.

Within the stage the species was found at 15 localities representing all generalized stratigraphic horizons. It was most abundant at localities 34, 66, and 87 which probably represent horizons near the bottom, middle, and top of the stage, respectively.

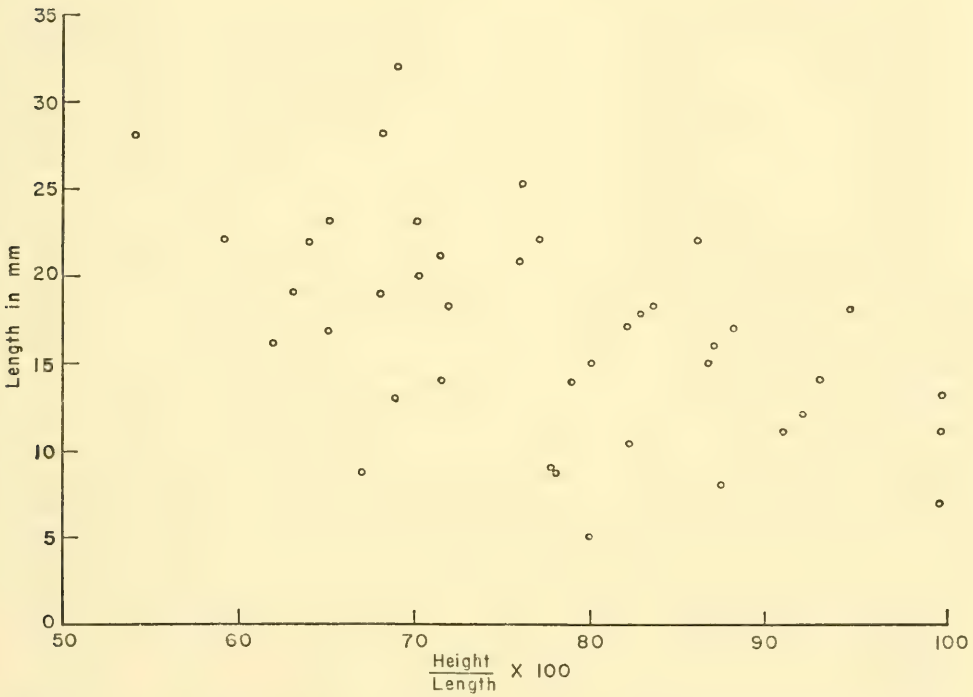

Figure 4. *Edmondia philipi.* Scatter diagram of length X form ratio (height expressed as percentage of length), showing size and shape variation in all measurable Chemung stage specimens. Note tendency toward greater elongation with increasing size.

Comparisons. The species, as defined here, is the only clearly documented representative of the genus in the North American Upper Devonian and so it is unlikely to be misidentified. Complete generic revision will probably be necessary before meaningful specific distinctions (other than stratigraphic position) can be worked out between the highly variable Devonian specimens of *Edmondia* and the many Carboniferous species assigned to the genus.

Discussion. The great shape variation in this species is clearly brought out by the graph (fig. 4), which shows the height to range from 54 percent to 100 percent of the length in a normal distribution based on all measurable Chemung stage specimens.

The Chemung stage material shows that only a consideration of variation in large samples can lead to meaningful species in this genus. For this reason, three loosely defined species erected by Hall from Cassadaga stage specimens are here considered subjective synonyms, the earliest valid name for the group being *Edmondia philipi* Hall and Whitfield. The Chemung specimens cannot be distinguished from this species without further knowledge of the Cassadaga forms, and accordingly this name will be used here. The authors probably took the specific name from Philipsburgh [now Belmont], New York, and therefore one of Hall's later illustrated specimens from this locality has been here designated as holotype. One of the synonyms, *E. subovata* Hall, was also reported from this locality, whereas the third, *E. tumidula* Hall, is reported from the nearby town of Hobbieville [now Belvidere]. In the explanations of the plates in the 1885 report, Hall cited two illustrated specimens of *E. tumidula* as being from Philipsburgh (pl. 64, figs. 16, 23), but this is apparently a mistake; the specimens are from "Rockville" as noted by Clarke and Ruedemann (1903, p. 382) and Whitfield and Hovey (1898, p. 274).

No holotypes will be designated here for these synonyms, however, because population defined species might eventually be erected for the more abundant Cassadaga forms. Should this prove practical, then Hall's names might be useful because specimens from many localities were included in each species, and this will permit a choice in the selection of type localities. Such revision of the Cassadaga species would probably lead to a new name for the Chemung specimens described here, but in any event it appears unlikely that more than one valid Chemung stage species can be defined in this genus.

Genus EOSCHIZODUS

Author. Cox, 1951, p. 367.

Type species. *Megalodus truncatus* Goldfuss (1840, p. 184) by original designation as the type of *Kefersteinia* Neumayr (1891, p. 788). *Eoschizodus* is a substitute name for *Kefersteinia* Neumayr, 1891, which is a junior homonym of the polychaete genus *Kefersteinia* Quatrefages, 1865.

Discussion. Cox (1951) has carefully reviewed the Paleozoic genus *Schizodus* and related genera and has concluded that these genera show two basic kinds of dentition. One group has fewer teeth and is most common in the Carboniferous and Permian. For this group Cox used the name *Schizodus* King, which was founded on the Permian species *Axinus obscurus* Sowerby. The later names *Protoschizodus* Koninck and *Prisconaia* Conrad were shown to be probable synonyms of *Schizodus*. The second group has a more complete development of the teeth, and is apparently most common in the Devonian. The generic name *Eoschizodus* was proposed for this group, the name being a replacement for the earlier preoccupied name *Kefersteinia* Neumayr, which has as its type the German Middle Devonian species *Megalodus truncatus* Goldfuss. None of the Chemung specimens of *"Schizodus"* has the teeth preserved and so the name *Eoschizodus* is used here tentatively; it is preferred only because of the Devonian age of its type species.

Eight species of *"Schizodus,"* in addition to those treated below, appear to have been described from the North American Upper Devonian. Three of these (*Schizodus oherni, S. frostburgensis,* and *S. trigonalis*) were described by Clarke and Swartz (1913, p. 646-647) from the Upper Devonian of Maryland. The remaining five species were described by Hall from the Finger Lakes and Cassadaga stages of New York (*Schizodus rhombeus, S. oblatus, S. degener, S. patulus,* and *S. eminens* of Hall's final 1885 report). Many of the figured specimens of these species appear distinctive enough to warrant separation from *Eoschizodus? chemungensis* (Conrad), but none can be adequately recognized without restudy.

Eoschizodus? chemungensis (Conrad)

(Plate 28, figures 1-12)

Nuculites chemungensis Conrad, 1842, p. 247, pl. 13, fig. 13.
Schizodus chemungensis (Conrad). Hall and Whitfield, 1870, p. 96. Hall, 1885, p. 453, pl. 75, figs.

37-41, 45. [?] Whiteaves, 1891, p. 241, pl. 30, figs. 5, 5a. Clarke and Swartz, 1913, p. 644, pl. 64, figs. 3-5. Branson, 1922, p. 113, pl. 27, figs. 4-7.

Cytherodon (Schizodus) chemungensis (Conrad). Hall, 1883, p. 18, pl. 75, figs. 37-40.

Schizodus quadrangularis Hall and Whitfield, 1870, p. 96 [nomen nudem].

Cytherodon (Schizodus) quadrangularis Hall, 1883, p. 18, pl. 75, figs. 31-34, 36, [not] fig. 35.

Schizodus chemungensis var. *quadrangularis* (Hall). Hall, 1885, p. 454, pl. 75, figs. 31-34, 36. Clarke and Swartz, 1913, p. 645, pl. 64, fig. 6.

Cardiomorpha rotunda Hall, 1883, p. 16, pl. 63, figs. 18, 19, [not] figs. 17, 20.

Paracyclas rotunda (Hall). Hall, 1885, p. 444, pl. 63, figs. 18, 19, pl. 95, fig. 21.

[?] *Nuculites appressa* Conrad, 1842, p. 248, pl. 15, fig. 4 [later references omitted, this is *Schizodus appressus* of Hall, 1885, and later authors].

[?] *Schizodus ellipticus* Hall and Whitfield, 1870, p. 96 [later references omitted].

[?] *Cytherodon (Schizodus) gregarius* Hall, 1883, p. 18, pl. 75, figs. 16-18 [later references omitted].

Revised description based on specimens from Chemung stage. Shell of large size (median length of 16 specimens 31 mm), equivalve, inequilateral. Shape variable, height ranging from 69 to 100 percent of length. Umbones large, central or anterior in position, directed forward, extending above dorsal margin. Surface sculpture not preserved on any composite mold, probably lacking. Lunule and escutcheon unknown. Hinge characters and dentition unknown. Ligament unknown. Musculature and interior features unknown. Shell material unknown.

Types. Holotype of *Nuculites chemungensis* Conrad, here designated, the specimen shown by Conrad, 1842, as fig. 13 of pl. 13, whereabouts unknown. Type locality: Chemung Narrows, New York, U.S.A. [locality 22 of this report]. Stratigraphic position: Upper Devonian, Chemung stage. Holotype of *Cytherodon (Schizodus) quadrangularis* Hall, here designated, the specimen shown by Hall, 1883, as fig. 34 of pl. 75, No. 6157/2 in the American Museum of Natural History, New York, New York, U.S.A. (pl. 28, fig. 10). Type locality: Tioga County, New York, U.S.A. Stratigraphic position: probably Upper Devonian, Chemung stage. Holotype of *Paracyclas rotunda* (Hall), here designated, the specimen shown by Hall, 1885, as fig. 19 of pl. 63, No. 2986 in the New York State Museum, Albany, New York, U.S.A. (pl. 28, fig. 11). Type locality: Kirkwood, Broome County, New York, U.S.A. Stratigraphic position: Upper Devonian, possibly Chemung stage.

Material. The revised description was based on about 25 specimens from the Chemung stage. Of these, 14 are permanently deposited in the Yale Peabody Museum, and the others are from the Hall collections at the American Museum of Natural History (see figured specimens).

Occurrence. The species is apparently most common in the New York Chemung stage, although Finger Lakes stage occurrences are represented by Hall's illustrated specimens from Cortland (1885, pl. 75, fig. 45) and Ithaca (1885, pl. 75, figs. 31, 38, 39, and 41; localities from Whitfield and Hovey, 1898, p. 305-307). The species is also known from the Upper Devonian of Maryland (Clarke and Swartz, 1913) and Missouri (Branson, 1922). The single specimen from the Upper Devonian of the Mackenzie River Basin which was figured by Whiteaves (1891, pl. 30) needs further confirmation. Post-Chemung and Middle Devonian specimens described by Hall as *Schizodus gregarius, S. appressus,* and *S. ellipticus* may, on restudy, prove indistinguishable from the Chemung specimens and they are therefore treated above as questioned synonyms.

Within the Chemung stage the species was sparingly represented at all generalized stratigraphic positions and was most common (five specimens) at Narrow Hill (locality 22), Conrad's original type locality.

Comparisons. The single Chemung species of *Eoschizodus* is unlikely to be confused with other Chemung stage pelecypods.

Discussion. The genus is distinguished from *Schizodus* solely on the basis of differences in dentition, and, because none of the Chemung specimens has the teeth preserved, the generic assignment is questioned. The type species of *Eoschizodus* is Devonian, whereas that of *Schizodus* is Permian, and this age difference is the only basis for pre-

ferring the name *Eoschizodus* for the Chemung species (see also the generic discussion).

Hall's species *Paracyclas rotunda,* which was based on two specimens from Broome County, New York, appears to be a somewhat more rounded variant of *E. chemungensis.*

Genus CYPRICARDELLA

Author. Hall, 1856 [1858?], p. 17.

Type species. *Cypricardella sub-elliptica* Hall (1856 [1858?], p. 17) by subsequent designation of Miller, 1889, p. 474.

Discussion. The only species of this distinctive genus described from the North American Upper Devonian, other than the two treated below, appear to be Clarke and Swartz's (1913, p. 654-657) four species from the Upper Devonian of Maryland. The Maryland species were defined on variations in size and shape, and none can be adequately recognized without restudy because some of the illustrated specimens of each presumed species are almost certainly *C. bellastriata* (i.e., pl. 65, fig. 11, pl. 66, figs. 6, 13, 18). Other specimens show differences which, if shown to be consistent, may be of specific value, although all of the illustrations of Maryland specimens could represent extreme variants of *C. bellastriata* except perhaps figs. 8 and 9 of pl. 66. Clarke and Swartz also reported specimens of *C. bellastriata* (p. 653), but these are not illustrated, whereas the three specimens they figured as "*C. gregaria*" almost certainly represent poorly preserved specimens of *C. bellastriata.*

The specimens of *Cypricardella complanata* and *Cypricardella tenuistriata* reported by Hall (1885) from the "Hamilton" of Schoharie County may represent other occurrences of the genus low in the New York Upper Devonian.

Important discussions of the genus are given by Williams and Breger (1916) and Haffer (1959).

Cypricardella bellastriata (Conrad)[1]

(Plate 29, figures 1-8; plate 30, figures 1-11)

Microdon bellastriata Conrad, 1842, p. 247, pl. 13, fig. 12. Hall, 1843, p. 196, fig. 2. Hall and Whitfield, 1869, p. 31. Hall, 1873, pl. 14, fig. 8.

Eodon bellistriatus (Conrad). Miller, 1877, p. 244.

Microdon (Microdonella) (Eodon) bellistriatus (Conrad). Hall, 1883, p. 18, pl. 73, figs. 7-22, pl. 74, figs. 4-10.

Cypricardella bellistriatus (Conrad). Hall, 1884b, pl. 6, figs. 1, 2. Grabau, 1899, p. 252, fig. 169.

Microdon (Cypricardella) bellistriatus (Conrad). Hall, 1885, p. 308, pl. 42, figs. 8b, 17-20, pl. 73, figs. 7-22, pl. 74, figs. 5-10.

Cypricardella bellistriata (Conrad). Whiteaves, 1892, p. 308, pl. 40, figs. 4, 5. Cockerell, 1905, p. 330. Clarke and Swartz, 1913, p. 653, pl. 65, figs. 8-10. Prosser and Kindle, 1913, p. 273, pl. 34, figs. 1-4. Williams, 1913, p. 69, pl. 6, figs. 1-21. [?] Patte, 1926, p. 99, pl. 7, fig. 7. Willard, 1939, pl. 25, fig. 28.

Microdonella bellistriata (Conrad). [?] Oehlert, 1881, p. 27, pl. 4, figs. 4a, 4b.

Revised description based on specimens from Chemung stage. Shell of medium size (median length of 38 specimens 17 mm), equivalve, inequilateral. Shape variable, height ranging from 53 to 91 percent of length. Umbones small, directed forward, extending to or very slightly above dorsal margin, distance from umbo to anterior extremity variable. Surface sculpture of coarse, regularly spaced concentric ridges present in well-preserved specimens. Lunule and escutcheon unknown. Prominent hinge plate present, represented on some composite molds as narrow, flat extension of dorsal margin (pl. 30, figs. 3-5). Dentition unknown. Ligament unknown. Anterior muscle scar obscurely represented on

[1] The Invalid Emendation *bellistriata* of Miller (1877, p. iv, 244) and subsequent authors is rejected here in favor of the Valid Original Spelling *bellastriata* as suggested in the Copenhagen Decisions (Hemming, 1953, p. 43, 55).

several composite molds (pl. 30, figs. 4, 11), other interior features unknown. Shell material unknown.

Types. Conrad's types appear to be lost, although they may be as yet unrecognized in the various Hall collections. None of Hall's illustrated specimens is recorded as coming from Smyrna, the type locality (see Whitfield and Hovey, 1898, p. 270, and Clarke and Ruedemann, 1903, p. 439-441) and it is doubtful that any of Hall's figures represent the specimen illustrated by Conrad (1842, pl. 13, fig. 12). Conrad's illustration and the distinctive nature of the species leave little doubt, however, that the interpretations of later authors correspond closely to the original species concept.

Material. The revised description was based on 70 specimens from the Chemung stage, all of which are permanently deposited in the Yale Peabody Museum.

Occurrence. This well-known Middle Devonian species was found at 14 localities representing all but the lowest horizons of the stage. No consistent differentiation could be made between specimens from the highest and lowest occurrences.

Elsewhere in the New York Upper Devonian the species is known only from the Finger Lakes stage faunas at Ithaca, New York (Hall, 1885, pl. 74, figs. 7, 8; also Hall, 1885, pl. 73, fig. 11; fide Whitfield and Hovey, 1898, p. 270; also Hall, 1885, fig. 17, fide Clarke and Ruedemann, 1903, p. 441; also Williams, 1913, pl. 6, figs. 7, 9-12). No unequivocal post-Chemung occurrences are known to me.

The species is probably represented in the Upper Devonian of Maryland by specimens figured by Clarke and Swartz (1913, see also the generic discussion).

Comparisons. Only the regular, strong concentric ridges distinguish well-preserved larger specimens from *C. gregaria*. Isolated small specimens and predominantly internal composite molds of these species may be indistinguishable (see below).

Discussion. The Upper Devonian occurrences of *C. bellastriata* have become well-known through the writings of H. S. Williams (1906-1907, 1913), who first considered the species to occur in the Upper Devonian only in association with the "recurrent" *Tropidoleptus* faunas. Williams' final work (1913, p. 68) on these faunas indicated, however, that *C. bellastriata* also occurs with more typical Chemung associations. This conclusion is confirmed by the present study. Only a few specimens were associated with the *Tropidoleptus* faunas, whereas many specimens were found at localities where the *Tropidoleptus* "zones" do not occur.

Cypricardella gregaria (Hall and Whitfield)

(Plate 31, figures 1-19; plate 32, figures 1-12)

Microdon gregaria Hall and Whitfield, 1869, p. 32.

Microdon (Microdonella) (Eodon) gregarius Hall [and Whitfield]. Hall, 1883, p. 18, pl. 73, figs. 1-6, pl. 74, figs. 1-3.

Microdon (Cypricardella) gregarius Hall [and Whitfield]. Hall, 1885, p. 309, pl. 73, figs. 1-6, pl. 74, figs. 1-4.

Cypricardella gregaria (Hall) [and Whitfield]. Grabau and Shimer, 1909, p. 535. [?] Clarke and Swartz, 1913, p. 654, pl. 65, figs. 16-18.

Revised description based on specimens from Chemung stage. Shell of medium size (median length of 81 specimens 19 mm), equivalve, inequilateral. Shape variable, height ranging from 50 to 87 percent of length. Umbones small, directed forward, extending to or very slightly above dorsal margin, distance from umbo to anterior extremity variable. Surface sculpture of fine, irregularly spaced concentric ridges present in well-preserved composite molds, commonly obscure. Small specimens show regularly spaced, very fine concentric ridges which are only occasionally preserved in earliest formed parts of larger specimens (pl. 31, figs. 5, 17; pl. 32, fig. 1). Some composite molds also show wide, shallow, irregularly spaced concentric depressions (pl. 31, figs. 12, 13). Lunule and escutcheon unknown. Prominent hinge plate present, represented on many composite molds as narrow, flat extension of dorsal margin. Dentition known from several hinge plate im-

pressions which show a single large, triangular cardinal tooth in the left valve and a corresponding socket in the right valve (pl. 31, figs. 18, 19). Ligament probably internal, known only from a single specimen having an obscurely preserved ligament groove posterior to the cardinal dentition (pl. 31, fig. 19). Anterior muscle scar obscurely represented on several composite molds (pl. 31, figs. 8, 14), posterior scar and other interior features unknown. Shell material unknown.

Types. Holotype of *Cypricardella gregaria* (Hall and Whitfield), here designated, the specimen shown by Hall, 1885, as fig. 2 of pl. 74, No. 6154/1:1 in the American Museum of Natural History, New York, New York, U.S.A. (pl. 31, figs. 1, 2). Type locality: Cortland, New York, U.S.A. Stratigraphic position: Upper Devonian, probably Finger Lakes stage.

Material. The revised description was based on 167 specimens from the Chemung stage, all of which are permanently deposited in the Yale Peabody Museum.

Occurrence. The species is known with certainty only from the Finger Lakes and Chemung stages of eastern and east-central New York. Hall's (1885, p. 310) mention of specimens from Portville, Cattaraugus County, New York, needs confirmation but may represent a post-Chemung occurrence.

Within the Chemung stage the species was abundant at six localities all representing horizons low in the stage. No specimens were found in the higher and more westerly exposures of the stage, where the species was apparently replaced by *C. bellastriata*. Hall's illustrated specimen from "near Elmira, New York" (Hall, 1885, pl. 74, fig. 4) is probably *C. bellastriata*, not *C. gregaria*.

Comparisons. The species is distinguishable from *C. bellastriata* solely on the basis of the finer and less regular concentric sculpture. Small specimens (which have regular sculpture) and predominantly internal composite molds are distinguishable only by association with more typical specimens.

Discussion. The Chemung specimens are the first to show the dentition in this species.

Genus CYPRICARDINIA

Author. Hall, 1859, p. 266.

Type species. *Cypricardinia lamellosa* Hall (1859, p. 266) by subsequent designation of Hall, 1885, p. xlvi.

Discussion. This distinctive genus is apparently known in the North American Upper Devonian only from the Chemung stage specimens described below. This restriction is surprising because the genus occurs in both the Middle Devonian and Mississippian of the eastern United States.

Discussions of the genus have been given by Whidborne (1892), Beushausen (1895), Hind (1897), Ruzicka (1951a) [not seen], and Haffer (1959).

Cypricardinia larocquei, n. sp.

(Plate 30, figures 18-23)

Description. Shell of medium size (median length of 4 specimens 18 mm), equivalve, inequilateral, strongly inflated. Variation in shape unknown. Ventral margin indented near mid-length by prominent radial depression. Umbones large, directed forward, extending above dorsal margin. Umbones anterior in position, distance from umbone to anterior extremity about ¼ of shell length. Surface sculpture preserved on composite molds as regular, widely spaced concentric grooves with interspaces showing finer discontinuous concentric ridges which give the surface a nodular appearance (pl. 30, fig. 23). Lunule and escutcheon unknown. Traces of a single strong lateral tooth preserved as posterior hinge plate impression of one left valve (pl. 30, figs. 20, 21), dentition otherwise unknown. Musculature and interior features unknown. Shell material unknown.

Types. Holotype: Yale Peabody Museum No. 21622, an external composite mold of a nearly complete left valve. Type locality: locality 60 described on p. 73 of this report.

Stratigraphic position: Upper Devonian, Chemung stage. Additional specimens: Yale Peabody Museum Nos. 21623-21626.

Material. The species is known only from the holotype and four additional specimens, all found at locality 60. Four of these specimens are well-preserved enough for illustration and all of them are permanently deposited in the Yale Peabody Museum.

Occurrence. The species is known only from the type locality.

Comparisons. These large, inflated, and obscurely sculptured shells are unlike any specimens of the genus known to me.

Discussion. A single left valve shows the characteristic strong lateral tooth of the genus (see Haffer, 1959, fig. 23).

The species is dedicated to Dr. J. A. Aurèle La Rocque of the Ohio State University in recognition of his valuable work on Devonian pelecypods.

Cypricardinia sp. A

(Plate 30, figures 12, 13)

Cypricardinia arcuata Hall, 1885, p. 486, pl. 79, fig. 17.
Cypricardinia indenta (Conrad) [in part]. Hall, 1883, pl. 19, pl. 79, fig. 17.

A single well-preserved left valve of a strongly sculptured *Cypricardinia* from an unknown locality "near Elmira" was described by Hall (1885) as the new species *C. arcuata*. The specimen is indistinguishable from several Middle Devonian specimens in the collections of the Yale Peabody Museum which probably represent the species *C. indenta* (Conrad), the name by which the Chemung specimen was first described by Hall (1883). My own collecting failed to turn up additional material of the species, and pending further discoveries it seems prudent not to apply a specific name to Hall's specimen.

Types. Holotype of *Cypricardinia arcuata* Hall, here designated, the specimen shown by Hall, 1885, as fig. 17 of pl. 79, No. 2341 in the New York State Museum, Albany, New York, U.S.A. (pl. 30, figs. 12, 13). Type locality: near Elmira, New York, U.S.A. Stratigraphic position: probably Upper Devonian, Chemung stage.

Cypricardinia? sp. B

(Plate 30, figures 14-17)

Two localities yielded small, poorly preserved specimens which probably represent a weakly sculptured species of *Cypricardinia*. They are quite similar to the Iowa Mississippian specimen figured by Hall (1885, pl. 79, fig. 22) as *C. sulciferus* (Winchell), but the Chemung material is too poor to warrant a specific name. Five specimens were found at locality 23B and three at locality 73.

21—Subquadrangle 1* of Van Etten (New York) 7.5′ quadrangle. Roadcut exposures along south side of State Highway 223, 7/10 mi. west of Swartwood (just east of Erin-Van Etten town line on map). I found no pelecypods at this locality, but a single specimen of *Pterinopecten strictus* collected by E. I. Leith for the Yale Peabody Museum was probably found at this exposure.

22—Subquadrangle 9 of Wellsburg (New York, Pennsylvania) 7.5′ quadrangle. Roadcut exposures along northeast side of State Highway 17 along the base of Narrow Hill, beginning 6.2 mi. west of Waverly and extending to the northwest for 5/10 mi. The exposures extend along that part of the highway which is immediately adjacent to the river on the topographic sheet. Most of the specimens from this locality were collected from fresh slumped material. This is the classic "Chemung" type locality which is referred to in the early literature as "Chemung Upper Narrows" or "Upper Narrows of Chemung River."

23—Subquadrangle 7 of Wellsburg (New York, Pennsylvania) 7.5′ quadrangle. Exposures along south side of Erie Railroad and State Highway 427, beginning at bridge across Chemung River, 2/10 mi. east of Wellsburg. The collections labeled locality 23A were made along the railroad tracks, from the highway bridge eastward to the end of the exposures (about 5/10 mi.). The collections labeled locality 23B were made at a small quarry on the south side of the highway (above the railroad tracks), 4/10 mi. west of the bridge.

27—Subquadrangle 5 of Binghamton West (New York) 7.5′ quadrangle. Small quarry 1.3 mi. southwest of Binghamton city limits on west side of improved road (Pennsylvania Ave. in city of Binghamton) which follows the valley of Bayless Creek. The quarry is at the base of Ingraham Hill at about the point at which the 1350 ft. contour crosses the road.

28—Subquadrangle 5 of Binghamton West (New York) 7.5′ quadrangle. Large quarry near the summit of Ingraham Hill, 5/10 mi. northeast of Ingraham Hill School. The topographic sheet clearly shows this large quarry. The rocks exposed here are of a transition facies between the redbeds and the fossiliferous marine units.

30—Subquadrangle 7 of Maine (New York) 7.5′ quadrangle. Roadcut exposures along southwest side of paved road along valley of Crocker Creek about 2.5 mi. northwest of Union Center. The exposures are just south of the bridge across Crocker Creek (west of the word "Crocker" on the map).

33—Subquadrangle 4 of Castle Creek (New York) 7.5′ quadrangle. Small roadcut on both sides of new road between Broome County Airport and village of West Chenango (new road not shown on 1942 topographic sheet). The exposures are 7/10 mi. southwest of West Chenango.

34—Subquadrangle 5 of Castle Creek (New York) 7.5′ quadrangle. Small quarry on south side of paved road connecting West Chenango and Glen Castle. The quarry is above St. Johns Pond, 1 mi. east of West Chenango.

35—Subquadrangle 4 of Castle Creek (New York) 7.5′ quadrangle. Small roadcut exposure on west side of paved road between New Ireland and West Chenango, 6/10 mi. north of the village of New Ireland.

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* The 7½ minute topographic sheets of the U. S. Geological Survey are divided by marginal ticks into nine 2½ minute subquadrangles. The 15 minute sheets are likewise divided into nine 5 minute subquadrangles. These subquadrangles are numbered here as follows:

1, 2, 3,
4, 5, 6,
7, 8, 9.

38—Subquadrangle 8 of Maine (New York) 7.5′ quadrangle. Creek bank and roadcut exposures along Twist Run Road, 6/10 mi. southeast of Union Center. The collections were made from a one-foot siltstone interval just above a six-foot dark shale along the south side of the road near the eastern end (highest part) of the exposure at an elevation of about 1,050 ft.

47—Subquadrangle 3 of Owego (New York) 7.5′ quadrangle. Hillside exposures on east side of State Highway 38-96, 7/10 mi. north of its junction with State Highway 17 in Owego.

48—Subquadrangle 9 of Candor (New York) 7.5′ quadrangle. Roadcut exposures along east side of State Highway 38 at its junction with State Highway 96 at Turners Bridge. I found no pelecypods at this locality, but a single specimen of *Lyriopecten anomiaeformis* collected by E. I. Leith for the Yale Peabody Museum was probably found at this exposure.

53—Subquadrangle 9 of Barton (New York) 7.5′ quadrangle. Roadcut exposures along north side of State Highway 17, beginning 5/10 mi. west of junction with State Highway 282 in Smithboro and extending westward for about 2/10 mi.

60—Subquadrangle 2 of Sayre (Pennsylvania) 15′ quadrangle. Exposures along south side of Delaware, Lackawana, and Western railroad tracks, beginning 1/10 mi. west of road junction in Wilawana and extending westward for about 3/10 mi.

64—Subquadrangle 6 of Waverly (New York, Pennsylvania) 7.5′ quadrangle. Roadcut exposures along east side of State Highway 34, beginning 5/10 mi. north of junction of Tallmadge Hill Road and extending northward about 3/10 mi.

65—Subquadrangle 6 of Waverly (New York, Pennsylvania) 7.5′ quadrangle. Roadcut exposures on east side of unimproved road parallel to and east of State Highway 34 south of Lockwood (between BM 858 and King School on map). The exposures begin about 1/10 mi. north of the southern junction with State Highway 34 and extend northward for about 3/10 mi.

66—Subquadrangle 8 of Waverly (New York, Pennsylvania) 7.5′ quadrangle. Roadcut exposures along north side of State Highway 17 on Glory Hill west of Waverly. The exposures begin about 1/10 mi. west of the Chemung-Tioga county line and extend westward for about 7/10 mi. Most of the specimens from this locality were collected from fresh slumped material.

72—Subquadrangle 8 of Waverly (New York, Pennsylvania) 7.5′ quadrangle. Exposures along northeast side of Erie Railroad tracks beginning about 2/10 mi. southeast of automobile bridge across Chemung River and extending northwestward for about 5/10 mi. This is probably the locality referred to in the early literature as "Lower Narrows of Chemung River."

73—Subquadrangle 4 of Elmira (New York, Pennsylvania) 7.5′ quadrangle. Small quarry in front of large industrial building on south side of Mountain View Road, 4/10 mi. northwest of junction with State Highway 328.

75—Subquadrangle 6 of Seeley Creek (New York, Pennsylvania) 7.5′ quadrangle. Exposures along bed of Hendy Creek at base of eastern extremity of Leach Hill. The collections were made from a small stratigraphic interval exposed at the point where the road from the village of Hendy Creek turns southwestward and begins to run parallel to the creek.

76—Subquadrangle 7 of Caton (New York, Pennsylvania) 7.5′ quadrangle. Roadcut exposures along south side of unimproved road following valley of Church Creek, 1.4 mi. east of junction with road running north from Lindley. The collections were made just east of the bridge crossing the creek. The specimens were found in fresh slumped material.

84—Subquadrangle 9 of Addison (New York) 7.5′ quadrangle. Roadcut and creek bank exposures along unimproved road following valley of Morgan Creek west of Lindley. The collections were made in the vicinity of the bridge across the creek, 4/10 mi. west of junction with U. S. Highway 15.

86—Subquadrangle 5 of Jackson Summit (Pennsylvania, New York) 7.5′ quadrangle.

Roadcut exposures on north side of State Highway 84 at base of Buck Hill, 1.75 mi. east of junction with U. S. Highway 15 in Tioga Junction.

87—Subquadrangle 4 of Jackson Summit (Pennsylvania, New York) 7.5′ quadrangle. Exposures in banks and bed of Mutton Lane Creek on both sides of State Highway 84 at base of Buck Hill, 1.2 mi. east of junction with U. S. Highway 15 in Tioga Junction.

88—Subquadrangle 1 of Sayre (Pennsylvania) 15′ quadrangle. Small quarry in massive sandstone on slope of unnamed hill south of Burnham Hill above Trout Run, near its junction with Bentley Creek. The quarry is on an unimproved side road about 1/10 mi. south of the paved road connecting Greenes Landing with the road following the valley of Bentley Creek. The road passing the quarry meets the east-west paved road 3/10 mi. west of Bentley Creek and the east-west paved road meets the Bentley Creek Valley road 1.5 mi. south of the village of Bentley Creek.

89—Subquadrangle 3 of Sayre (Pennsylvania) 15′ quadrangle. Roadcut exposures at Tioga Point, east of paved highway connecting East Athens and Sheshequin. The exposures begin about 3.4 mi. south of East Athens and extend about 9/10 mi. southward. The few pelecypods found at this locality were collected near the highest part of the long roadcut.

93—Subquadrangle 3 of Towanda (Pennsylvania, New York) 15′ quadrangle. Small cliff exposure south of State Highway 838, 5/10 mi. east of junction with State Highway 187.

94—Subquadrangle 3 of Towanda (Pennsylvania, New York) 15′ quadrangle. Roadcut exposures on north side of paved road connecting Windham Center and Windham Summit. The exposures are 2/10 mi. west of the village of Windham Center.

96—Subquadrangle 1 of Towanda (Pennsylvania, New York) 15′ quadrangle. Roadcut exposure on south side of paved road connecting East Athens and Litchfield, 1.4 mi. east of East Athens. The exposure is about 2/10 mi. west of the Athens-Litchfield town line.

97—Subquadrangle 1 of Towanda (Pennsylvania, New York) 15′ quadrangle. Roadcut exposure on west side of paved road connecting East Athens and Rome. The exposure is about 1/10 mi. south of the bridge over Satterlee Creek, 1.1 mi. north of Campbell School.

101—Subquadrangle 1 of Sayre (Pennsylvania) 15′ quadrangle. Exposures in banks and bed of small stream making Three Falls Glen west of Ridgebury. The exposures begin 1/10 mi. west of Ridgebury and extend westward (upstream) about 8/10 mi. This abundantly fossiliferous locality was discovered too late for extensive collecting. The few specimens collected here were found in the higher part of the glen above the falls.

102—Subquadrangle 1 of Sayre (Pennsylvania) 15′ quadrangle. Exposures in banks and bed of Justice Run southwest of Ridgebury. The collections from this locality were made from a single bedding plane exposed in the bed of the creek 3/10 mi. east of the first (easternmost) bridge over the stream. The layer was 1 ft. below the top of a 2 ft. waterfall, about 200 ft. downstream (east) from a large cliff exposure on the south bank of the stream.

103—Subquadrangle 1 of Elmira (New York, Pennsylvania) 7.5′ quadrangle. Roadcut exposures along north side of private dead-end road extending up the southeast side of Hawley Hill. The road meets State Highway 17E as the first road southeast of the Fitch Bridge road. The private road is shown on the topographic sheet, and the collections were made at an elevation of about 1,100 ft.

104—Subquadrangle 3 of Seeley Creek (New York, Pennsylvania) 7.5′ quadrangle. Roadcut exposures along the paved road leading up Harris Hill north of Pine Grove School. The exposures begin about 5/10 mi. north of Pine Grove School and extend northward for about 7/10 mi. The specimens from this locality were collected from fresh slumped material.

105—Subquadrangles 7 and 8 of Corning (New York) 7.5′ quadrangle. Cliff exposures at

base of Higman Hill above the New York Central railroad tracks west of the State Highway 17 bridge across the Chemung River (bridge not shown on 1953 topographic sheet). The single pelecypod collected here was found in fresh slumped material. It seems geographically probable that this is the source of Hall's many specimens from "Blossburg Railroad at Painted Post, New York," although I found only one specimen at the locality.

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INDEX

Actinopterella boydi, 27
Actinopteria, genus, 26-29
Actinopteria alpha, 27
Actinopteria angustirostra, 28
Actinopteria auriculata, 27
Actinopteria beta, 27
Actinopteria boydi, 27-28; comparisons, 28, 29; holotype of, 28; occurrence of, 28; revised description of, 27-28; synonyms of, 27; pl. 3
Actinopteria decussata, 28
Actinopteria delta, 26, 28
Actinopteria epsilon, 26, 28
Actinopteria eta, 26, 28
Actinopteria iota, 26, 28
Actinopteria kappa, 26, 28
Actinopteria perobliqua, 28
Actinopteria perstrialis, 26, 28
Actinopteria pleuroptera, 28
Actinopteria quadrula, 28
Actinopteria sola, 27
Actinopteria sp. A, 28, pl. 3
Actinopteria sp. B, 28, 29, pl. 3
Actinopteria subdecussata, 27, 28
Actinopteria tenuistriata, 26, 28
Actinopteria theta, 26, 28
Actinopteria zeta, 26, 28, 29, 30
American Commission on Stratigraphic Nomenclature, 5
American Museum of Natural History, 3, 15; specimens of *Avicula longispina,* 34; *Avicula pecteniformis,* 37; *Cypricardella gregaria,* 70; *Cytherodon (Schizodus) quadrangularis,* 67; *Edmondia philipi,* 65; *Glossites depressus,* 46; *Grammatodon (Cosmetodon) chemungensis,* 25; *Grammysioidea subarcuata,* 58; *Leptodesma becki,* 34; *Leptodesma naviforme,* 33; *Leptodesma robustum,* 34; *Lyriopecten anomiaeformis,* 53; *Lyriopecten cymbalon,* 52; *Mytilarca carinata,* 39; *Orthonota rigida,* 63; *Palaeoneilo bisulcata,* 20; *Palaeoneilo angusta,* 20; *Pseudaviculopecten striatus,* 50; *Pterinea consimilis,* 37; *Pterinea rigida,* 37; *Pterinea prora,* 37; *Ptychodesma minor,* 41; *Ptychodesma neglectum,* 41; *Spathella typica,* 47; *Vertumnia avis,* 57; *Vertumnia reversa,* 57
Apalachin quadrangle, 6
Arca keyserlingii, 24
Arca rostrata, 23
Arkell, W. J., 25
Athyris angelica, 6
Avicula angustirostra, 27, 28
Avicula boydii, 27
Avicula chemungensis, 29, 30, 36
Avicula decussata, 26, 27
Avicula longispina, 33, 34; holotype of, 34, pl. 9
Avicula orbiculata, 51
Avicula pecteniformis, 36; holotype of, 37; pl. 12; synonym of, 37
Avicula perobliqua, 27, 28
Avicula pleuroptera, 27
Avicula protexta, 33; holotype of, 34, pl. 9
Avicula spinigera, 33
Avicula tricostata, 52
Aviculopecten, genus, 48
Aviculopecten aequalata, 49
Aviculopecten aequilateralis, 49
Aviculopecten cancellatus, 49
Aviculopecten celsus, 49
Aviculopecten convexus, 49
Aviculopecten dolabriformis, 49
Aviculopecten duplicatus, 49
Aviculopecten ellipticus, 49
Aviculopecten fasciculatus, 49, 50
Aviculopecten formio, 49
Aviculopecten idas, 49
Aviculopecten orestes, 50
Aviculopecten patulus, 49
Aviculopecten phorcus, 49
Aviculopecten plenus, 49; holotype of, 50, pl. 20
Aviculopecten princeps, 48
Aviculopecten repletus, 50
Aviculopecten rugaestriatus, 49
Aviculopecten signatus, 49
Aviculopecten squama, 49
Aviculopecten striatus, 49
Aviculopecten tenuis, 49
Axinus obscurus, 66

Baird, Donald, 13
Beushausen, Ludwig, 16, 63
Beushausenia, genus, 25
Binghamton quadrangle, 6
Brachiopod horizons, 4
Bradley, W. H. and others, 6
Branson, E. B., 24, 25
Buchiola, 13
Buck's Quarry, 20, 25, 41, 42, 46, 53, 57, 58, 63
"Burgess Vibro-Graver," 13

Cardiomorpha rotunda, 67
Cassadaga stage, occurrence of *Athyris angelica,* 6; *Aviculopecten* species, 49; *Edmondia philipi,* 65, 66; *Eoschizodus,* 66; *Glossites depressus,* 46; *Grammysia elliptica,* 60; *Grammysioidea subarcuata,* 58; *Leiopteria nitida,* 30; *Leptodesma,* 31; *Modiomorpha,* 44; *Modio-*

morpha tioga, 45; *Mytilarca chemungensis*, 39; *Palaeoneilo brevicula*, 16; *Palaeoneilo elongata*, 16; *Palaeoneilo linguata*, 17; *Palaeoneilo similis*, 17; *Pterinea avis*, 57; *Pterinopecten strictus*, 55; *Pterinopecten suborbicularis*, 56
Caster, K. E., 50
Catskill Delta, 4
Cayuta Creek, 44
Cayuta formation, 2, 4, 5
Chapman sandstone, 11
Chemung stage, general discussion of, 1-5; occurence and revision of species, 8, 11, 12, 15; preservation of specimens, 13; type region, 2; also see: Yale University Peabody Museum of Natural History collections of Chemung stage specimens
"Chemung" of Maryland, occurrence of *Leiopteria nitida*, 30; *Leptodesma elongatum* 32; *Lyriopecten tricostata*, 52; *Modiomorpha subangulata*, 44; *Nuculoidea corbuliformis*, 23; *Palaeoneilo crassa*, 16
Chernyshev, B. I., 23
Cimitaria, genus, 63-64; type species of, 63
Cimitaria angulata, 7, 63-64; holotype of, 63; occurrence of, 63; revised description of, 63; synonyms of, 63
Cimitaria recurva, 63
Clarke, J. M., 31; with Rudolph Ruedemann, 69
Colton, George W., 3
Conewango stage, occurrence of *Aviculopecten* species, 49; *Aviculopecten* cf. *striatus*, 50; *Goniophora curvata*, 42; *Goniophora ruedemanni*, 42; *Leptodesma* species, 31; *Leptodesma carinifera*, 32; *Lyriopecten alternatus*, 52; *Nucula globularis*, 22; *Palaeoneilo similis*, 17; *Sphenotus palmerae*, 62
Conrad, T. A., 2, 19, 24, 28, 30-31
Cooper, G. A., 1, 2
Cornellites, genus, 26, 35-38; type species of, 35
Cornellites chemungensis, 30, 36-38; occurrence of, 37; revised description of, 36; scatter diagram, 38; synonyms of, 36; pl. 12, 13, 14
Corning-Tioga quadrangles, 6
Cox, L. R., 66
Crenipecten, genus, 48
Ctenodonta, genus, 16
Cucullea opima, 21
Cuvierian school, 10
Cypricardella, genus, 68-70; type species of, 68
Cypricardella bellastriata, 68-69; comparisons, 69, 70; occurrence of, 69; revised description of, 68-69; pl. 29
Cypricardella bellistriatus, 68
Cypricardella gregaria, 68, 69; comparisons, 69, 70; holotype of, 70; occurrence of, 70; revised description of 69-70; pl. 31
Cypricardella sub-elliptica, 68
Cypricardia cymbaeformis, 42
Cypricardinia, genus, 70-71; type species of, 70
Cypricardinia arcuata, 70; holotype of, 71; pl. 30
Cypricardinia indenta, 71
Cypricardinia lamellosa, 70
Cypricardinia larocquei, n. sp., 70-71; description of, 70; holotype of 70-71; pl. 30
Cypricardinia sulciferus, 71
Cypricardinia sp. A, 7, 71; holotype of, 71; synonyms of, 71; pl. 30
Cyricardinia sp. B, 71; pl. 30
Cypricardites alta, 45
Cypricardites carinata, 42, 43
Cypricardites chemungensis, 42
Cypricardites mytiloides, 45
Cypricardites recurva, 63
Cytherodon (*Schizodus*) *chemungensis*, 67
Cytherodon (*Schizodus*) *gregarius*, 67
Cytherodon (*Schizodus*) *quadrangularis*, 67; holotype of, 67; pl. 28

de Witt, Wallace, 4, 5
Dunbar, Carl O., 2, 3

Edentulous genera, 1, 12, 61
Edmondia, genus, 64-66; type species of, 64
Edmondia philipi, 64-66; comparisons, 65; holotype of, 64-65; occurrence, 65; revised description of, 64; scatter diagram, 65; synonyms of, 64; pl. 27
Edmondia rhomboidea, 64
Edmondia subcarinata, 64
Edmondia subovata, 64, 66
Edmondia tenuistriata, 64
Edmondia transversa, 64
Edmondia tumidula, 64, 66
Elmira-Troy quadrangles, 6
Eodon bellistriatus, 68
Eoschizodus, genus, 66-68; type species of, 66
Eoschizodus chemungensis, 66-68; occurrence of, 67; revised description of, 67; synonyms of, 66-67; pl. 28
Erie shale, 17

Facies relations, 4
Finger Lakes stage, horizons, 4, 5, 13; occurrence of *Actinopteria boydi*, 28; *Actinopteria* sp. A, 28; *Cypricardella bellastriata*, 69; *Cypricardella gregaria*, 70; *Eoschizodus*, 66; *Eoschizodus chemungensis*, 67; *Goniophora chemungensis*, 43; *Grammysioidea subarcuata*, 58; *Leiopteria nitida*, 30; *Leptodesma*, 31; *Leptodesma rogersi*, 35; *Lyriopecten cymbalon*, 53; *Lyriopecten priamus*, 53; *Lyriopecten tricostatus*, 53; *Modiomorpha*, 44; *Nucula diffidens*, 22; *Nuculoidea corbuliformis*, 23; occurrence of *Palaeoneilo constricta*, 18; *Palaeoneilo emarginata*, 17; *Palaeoneilo filosa*, 17; *Palaeoneilo plana*, 17; *Pterinopecten strictus*, 55; *Ptychodesma nanum*, 41; *Sphenotus tiogensis*, n. sp., 62; *Vertumnia reproba*, 56

Fisher, Donald W., 2, 3

Generic level revision, 12
Generic names for Paleozoic pelecypods, 12
Geographic and stratigraphic distribution of fauna, 5
Glossites, genus, 45-47; type species of, 45
Glossites depressus, 46; comparisons, 46; holotype of, 46; occurrence of, 46; revised description of, 46; synonyms of, 46; pl. 18
Glossites ellipticus, 46
Glossites lingualis, 46
Glossites patulus, 46
Glossites procerus, 46
Glossites rudicula, 46
Glossites subnasutus, 46
Goniophora, genus, 42-44, 62; type species of, 42
Goniophora cayutensis, n. sp., 43-44; comparisons, 43, 44; description of, 43; holotype of, 43; occurrence of, 43; pl. 18
Goniophora chemungensis, 42-43; comparisons, 43, 44; holotype of, 43; occurrence of, 43; revised description of, 43; synonyms of, 42; pl. 17
Goniophora curvata, 42
Goniophora minor, 44
Goniophora ruedemanni, 42
Goniophora sp., 44; pl. 18
Goniophora subrecta, 42, 43
Goniophora trigona, 42, 43
Grammatodon (Cosmetodon), genus, 24-25
Grammatodon (Cosmetodon) chemungensis, 25; holotype of, 25; occurrence of, 25; revised description of, 25; synonyms of, 25; pl. 4
Grammysia, genus, 59-61; type species of, 59
Grammysia alveata, 57, 59, 60
Grammysia arcuata, 57, 59, 60
Grammysia bisulcata, 59, 60
Grammysia chemungensis, 60, 61; holotype of, 60
Grammysia circularis, 59
Grammysia communis, 57, 58, 59, 60
Grammysia dubia, 60
Grammysia duplicata, 58, 60
Grammysia elliptica, 59, 60-61; occurrence of, 60; revised description of, 60; synonyms of, 60; pl. 25
Grammysia erecta, 59, 60
Grammysia (Grammysioidea) princiana, 57, 59
Grammysia hamiltonensis, 59
Grammysia hannibalensis, 58, 59, 60
Grammysia (Leptodomus) subarcuata, 58
Grammysia lirata, 57
Grammysia magna, 59, 60, 61
Grammysia minor, 58, 60
Grammysia nodocostata, 59, 60
Grammysia plena, 60
Grammysia sp., 61; pl. 25
Grammysia subarcuata, 57, 59, 60
Grammysia subarcuata-communis-hannibalensis type, 57
Grammysia undata, 58, 59, 60
Grammysioidea, genus, 57-59; post-Chemung occurrence of, 58; pre-Chemung occurrence of, 57; type species of, 57
Grammysioidea sp., 59; pl. 25
Grammysioidea subarcuata, 58; holotype of, 58; occurrence of, 58; revised description of, 58; synonyms of, 58; pl. 25
Gregory, Joseph T., 3

Hall, James, 2, 7, 8, 9, 11, 13, 16, 17, 18, 19, 20, 26, 28, 30, 31, 38, 39, 45, 47, 48, 49, 51
"Hamilton Group," 16, 18; specimens of Chenango County, 35; specimens of Schoharie County, 29, 49, 51, 52, 54, 68
Holotypes, designation of, 14-15
Heterodont genera, 1

Inoceramus chemungensis, 38
International Commission on Zoological Nomenclature, 16
Isocardia unioniformis, 64
Isoculia, genus, 59

Kefersteinia, genus, 66
Key horizons, field tracing of, 4
Kilfoyle, Clinton F., 3
Knight, J. Brookes, 12

Lamellibranchiata, 8
La Rocque, J. A. Aurèle, 71
Leda diversa, 23, 24
Leda (Nuculana) perstriata, 24
Leda (Nuculana) rostellata, 24
Leiopteria genus, 26, 29-31
Leiopteria bigsbyi, 29
Leiopteria chemungensis, 29
Leiopteria cornelli, 29
Leiopteria dekayi, 29, 30, 31
Leiopteria leai, 29
Leiopteria linguiformis, 29; holotype of, 30; pl. 5
Leiopteria mitchelli, 29
Leiopteria nitida, 29-30; holotype of, 30; occurrence of, 30; revised description of, 29; synonyms of, 29; pl. 5, 6
Leiopteria sayi, 29
Leiopteria torreyi, 29
Leiopteria troosti, 29
Leith, Edward I., 3, 7
Leptodesma, genus, 26, 29, 31-35; stratigraphic distribution of, 31; type species of, 31; validity of genus, 26
Leptodesma agassizi, 33; holotype of, 34; pl. 9
Leptodesma becki, 33; holotype of, 34; pl. 10
Leptodesma carinifera, 32
Leptodesma creon, 33; holotype of, 34; pl. 9
Leptodesma demus, 33; holotype of, 35; pl. 9
Leptodesma elongatum, 32
Leptodesma eolus, 32
Leptodesma flaccidum, 33; holotype of, 35
Leptodesma leiopteroides, 32
Leptodesma lesleyi, 33, 35

Leptodesma longispinum, 33
Leptodesma loxias, 33; holotype of, 35; pl. 9
Leptodesma medon, 33; holotype of, 34; pl. 9
Leptodesma naviforme, 32-33, 35; comparisons, 33; holotype of, 32, 33; occurrence of, 33; revised description of; 32; pl. 7, 8
Leptodesma parallelum, 32
Leptodesma protextum, 33
Leptodesma quadratum, 33, 35
Leptodesma robustum, 33; holotype of, 34; pl. 9
Leptodesma rogersi, 31, 33; holotype of, 34; pl. 9
Leptodesma shumardi, 33; holotype of, 34; pl. 9
Leptodesma spinigerum, 31, 32, 33-35; comparisons, 33; holotype of, 34; occurrence of, 35; revised description of, 33; pl. 8, 9, 10, 11
Leptodesma transversa, 32
Leptodomus, genus, 63
Limoptera, genus, comparison with *Cornellites*, 36
Liopteria auriculata, 29
Liopteria bigsbyi, 29, 30
Liopteria marylandica, 29
Lithodomus, genus, 47
Lithophaga, genus, comparison with *Spathella*, genus, 47, 48
Locality Register, 5, 72-75
Lower Chemung stage, 6
Lunulicardium ornatum, 13
Lunulicardium transversum, 13
Lyriopecten, genus, 48, 51-54, 56; type species of, 51
Lyriopecten alternatus, 52
Lyriopecten anomiaeformis, 53; comparisons, 53; holotype of, 53; occurrence of, 53; revised description of, 53; pl. 22
Lyriopecten cymbalon, 52; holotype of, pl. 22
Lyriopecten fasciatus, 51
Lyriopecten interradiatus, 51
Lyriopecten macrodontus, 54
Lyriopecten magnificus, 7, 54; holotype of, 54; occurrence of, 54; revised description of, 54; synonyms of, 54; pl. 23
Lyriopecten orbiculatus, 48, 49
Lyriopecten polydorus, 51
Lyriopecten priamus, 51
Lyriopecten solex, 51
Lyriopecten tricostatus, 52; holotype of, 52; occurrence of, 52; revised description of, 52; synonyms of, 52; pl. 21

McAlester, Donald J., 3
Macrodon, genus, 25
Macrodon chemungensis, 25
Matrix, removal of, 13
Megalodus truncatus, 66
Metamorphic species, 11
Microdon bellastriata, 68
Microdon (Cypricardella) bellistriatus, 68
Microdon (Cypricardella) gregarius, 69
Microdon gregaria, 69
Microdon (Microdonella) (Eodon) bellistriatus, 68
Microdon (Microdonella) (Eodon) gregarius, 69
Microdonella bellistriata, 68
Middle Chemung stage, 6
Miller, S. A., 8, 61
Modiomorpha, genus, 44; type species of, 44
Modiomorpha alta, 45
Modiomorpha amygdalina, 46
Modiomorpha complanata, 45
Modiomorpha macilenta, 45
Modiomorpha missouriensis, 44
Modiomorpha mytiloides, 44, 45; occurrence of, 45; revised description of, 45; synonyms of, 45; pl. 19
Modiomorpha mytiloides milwaukeensis, 45
Modiomorpha neglecta, 41, 42, 44
Modiomorpha planulata, 45
Modiomorpha quadrula, 44
Modiomorpha recurva, 44
Modiomorpha rigida, 44
Modiomorpha subalata var. *chemungensis*, 44
Modiomorpha subangulata, 44
Modiomorpha tioga, 44, 45
Monomyaria, 8
Monotis princeps, 48
Myalina, genus, 40-41; type species of, 40
Myalina newelli, n. sp., 40-41; comparisons, 40; description of, 40; holotype of, 40; occurrence of, 40; pl. 16
Myalina sp., 41; pl. 16
Mytilarca, genus, 38-40; comparison with *Selenimyalina*, 38; type species of, 38
Mytilarca attenuata, 38, 39; holotype of, 39; pl. 16
Mytilarca carinata, 38, 39; holotype of, 39; pl. 15
Mytilarca chemungensis, 38-40; comparisons, 40; holotype of, 39; occurrence of, 39; revised description of, 39; synonyms of, 38, 39; pl. 15, 16
Mytilarca gibbosa, 38
Mytilarca lata, 38
Mytilarca regularis, 38
Mytilarca simplex, 38
Mytilarca umbonata, 38
Mytiloid genera, 1, 12
Mytilus chemungensis, 39

Neotypes, designation of, 15
Nettleroth, Henry, 8
New York Geological Survey, 2
New York State Museum, 3, 15; specimens of *Aviculopecten plenus*, 50; *Cimitaria angulata*, 63; *Cypricardinia arcuata*, 71; *Glossites depressus*, 46; *Goniophora chemungensis*, 43; *Grammatodon (Cosmetodon) chemungensis*, 25; *Leiopteria nitida*, 30; *Leptodesma agassizi*, 34; *Leptodesma creon*, 34; *Leptodesma demus*, 34; *Leptodesma loxias*, 34; *Leptodesma medon*, 34; *Leptodesma shumardi*, 34; *Lyriopecten magnificus*, 54; *Lyriopecten tricostatus*, 52; *Mytilarca attenuata*, 39; *Palaeo-*

neilo angusta, 20, 21; *Palaeoneilo bisulcata*, 20; *Paracyclas rotunda*, 67; *Pterinea interstrialis*, 37; *Pterinopecten strictus*, 55
Newell, Norman D., 2, 3, 40-41, 48, 49
Nomenclatural enthusiasm, 11
Nucula, genus, 21, 22
Nucula diffidens, 22
Nucula globularis, 22
Nucula lamellata, 22
Nucula lirata, 22
Nucula opima, 22
Nucula randalli, 21
Nucula rescuensis, 22
Nucula snyderensis, 22
Nucula subtrigona, 22
Nuculana, genus, 23-24; type species of, 23
Nuculana rostellata, 24; comparisons, 24; occurrence of, 24; revised description of, 24; synonyms of, 24; pl. 2
Nuculana sp., 24; comparison with *Nuculana rostellata*, 24; pl. 2
Nuculites, Maine Silurian specimens of, 11
Nuculites appressa, 67
Nuculites chemungensis, 66; holotype of, 67
Nuculites constricta, 16, 17
Nuculites maxima, 17, 19
Nuculites rostellata, 24
Nuculoid genera, 1, 12, 16
Nuculoidea, genus, 21-23; type species of, 21
Nuculoidea corbuliformis 22-23; comparisons, 23; occurrence of, 23; revised description of, 22; synonyms of, 22; pl. 3

Orthonota rigida, 62, 63; holotype of, 63
Owego-Towanda quadrangles, 6

Palaeaneilo brevis, 17
Palaeaneilo constricta, 17
Palaeaneilo plana, 17
Palaeoneilo, genus, 16-21; type species of, 16
Palaeoneilo angusta, 18, 20, 21; comparisons, 20, 21; holotype of, 21; occurrence of, 21; revised description of, 21; scatter diagram, 20; pl. 2
Palaeoneilo arata, 16
Palaeoneilo bisulcata, 18, 19-21; comparisons, 19-21; holotype of, 19; occurrence of, 19; revised description of, 19; scatter diagram, 20; synonyms of, 19; pl. 2
Palaeoneilo brevicula, 16
Palaeoneilo constricta, 17-19; comparisons, 18; holotype of, 18; occurrence of, 18; revised description of, 17-19; synonyms of, 17; pl. 1
Palaeoneilo crassa, 16
Palaeoneilo elongata, 16
Palaeoneilo emarginata, 17
Palaeoneilo fecunda—Palaeoneilo tenuistriata group, 17
Palaeoneilo filosa, 16, 19
Palaeoneilo linguata, 17
Palaeoneilo maxima, 17, 18, 19
Palaeoneilo muricata, 19
Palaeoneilo petila, 17
Palaeoneilo similis, 17
Pan-American Petroleum Corporation Fellowship, 3
Paracyclas, genus, 44
Paracyclas rotunda, 67; holotype of, 67; pl. 28
Parallelodont genera, 1
Pectinoid genera, 1, 48
Pelecypod localities of Chemung stage, 6
"Permamold," 13
Perrysburg formation, 6
"Portage Group," 54
Prisconaia, genus, 66
Protobranchiata, 12
Protoschizodus, genus, 66
Pseudaviculopecten bradfordensis, n. sp., 51; comparisons, 51; description of, 51; holotype of, 51; occurrence of, 51; pl. 20
Pseudaviculopecten fasciculatus, 50; occurrence of, 51; revised description of, 50; synonyms of, 50; pl. 20
Pseudaviculopecten striatus, 49; holotype of, 50; occurrence of, 50; revised description of, 49-50; synonyms of, 49; pl. 20
Pterinea, genus, 26, 56
Pterinea bisculcata, 59
Pterinea boydi, 27
Pterinea concentrica, 44
Pterinea chemungensis, 30, 36
Pterinea consimilis, 36; holotype of, 37; pl. 12; paratype of, pl. 14
Pterinea dispanda, 36, 37
Pterinea fasciculata, 35
Pterinea flabella, 36
Pterinea husseyi, 36
Pterinea interstrialis, 36; holotype of, 37; pl. 12
Pterinea longispina, 33
Pterinea newarkensis, 36
Pterinea nodocosta, 36
Pterinea prora, 36; holotype of, 37; pl. 12
Pterinea protexta, 33
Pterinea reversa, 56
Pterinea reversa var. *avis*, 56
Pterinea rigida, 36; pl. 12
Pterinea suborbicularis, 55
Pterinea (*Vertumnia*) *avis*, 56
Pterinea (*Vertumnia*) *reversa*, 56
Pteronites spinigerus, 33
Pterinopecten, genus, 54-56; type species of, 54; validity of genus, 48
Pterinopecten atticus, 54
Pterinopecten (*Aviculopecten*) *strictus*, 55
Pterinopecten crenicostatus, 55, 56
Pterinopecten crenulatus, 55
Pterinopecten dispandus, 55, 56
Pterinopecten erectus, 55
Pterinopecten filitextus, 54
Pterinopecten imbecilis, 55
Pterinopecten neptunus, 55, 56
Pterinopecten strictus, 54, 56; comparisons, 54; holotype of, 54; occurrence of, 54; revised description of, 54; synonyms of, 54; pl. 23
Pterinopecten suborbicularis, 55-56; compari-

sons, 56; occurrence of, 56; revised description, 56; synonyms of, 55; pl. 23
Pterinopecten undosus, 49, 54
Pterinopecten vertumnus, 54
Pterioid genera, 1
Ptychodesma, genus, 41-42, 44; type species of, 41
Ptychodesma knappianum, 41, 42
Ptychodesma minor, 41, 42; holotype of, 41; pl. 16
Ptychodesma nanum, 41
Ptychodesma neglectum, 41-42; holotype of, 41; occurrence of, 42; revised description of, 41; synonyms of, 41; pl. 16

Rasseti, Franco, 13
Rickard, Lawrence V., 2, 3, 5
Rock-stratigraphic nomenclature, 5
Rodgers, John, 4
Ruedemann, Rudolph (with J. M. Clarke), 69

Sanders, John E., 3
Sanguinolites, genus, 48, 63
Sanguinolites arcaeformis, 61
Sanguinolites chemungensis, 42
Sanguinolites undatus, 62
Sanguinolites ventricosus, 47
Schizodont genera, 1
Schizodus, genus, 66
Schizodus appressus, 67
Schizodus chemungensis, 66
Schizodus chemungensis var. *quadrangularis*, 67
Schizodus degener, 66
Schizodus ellipticus, 67
Schizodus eminens, 66
Schizodus frostburgensis, 66
Schizodus oblatus, 66
Schizodus oherni, 66
Schizodus patulus, 66
Schizodus quadrangularis, 67
Schizodus rhombeus, 66
Schizodus trigonalis, 66
Schuchert, Charles, Fund, 3
Selenimyalina, genus compared with *Mytilarca*, 38
Snyder Creek shale, 22
Spathella, genus, 47; type species of, 47
Spathella typica, 47-48; comparisons, 46; holotype of, 47-47; occurrence of, 48; revised description of, 47; synonyms of, 47; pl. 19
Species-level revisions of Paleozoic pelecypods, 11
Species-making, 9, 10
Sphenotus, genus, 61-63; type species of, 61
Sphenotus arcaeformis, 62
Sphenotus chemungensis, 62
Sphenotus clavulus, 61
Sphenotus contractus, 61
Sphenotus cuneatus, 61
Sphenotus palmerae, 62
Sphenotus subtortuosus, 61
Sphenotus sp., 7, 62-63; synonyms of, 62; pl. 27
Sphenotus tiogensis, n. sp., 62; comparisons, 62, 63; description of, 62; holotype of, 62; occurrence of, 62; pl. 26
Spirifer disjunctus, 5
Stratigraphic and geographic distribution of fauna, 5
Sutton, Robert G., 3, 4, 5
Synonymy, notes on, 14

Taxonomic splitting, 12
Tropidoleptus faunas, 69

Upper Chemung stage, 6
Upper Devonian stratigraphy of New York and Pennsylvania, 4

Vanuxem, Lardner, 30-31
Vertumnia, genus, 48, 56; type species of, 56
Vertumnia avis, 56; holotype of, 57; pl. 24
Vertumnia reproba, 56
Vertumnia reversa, 56-57; holotype of, 57; occurrence of, 57; revised description of, 57; synonyms of, 56; pl. 24
Vokes, H. E., 22

Waage, Karl M., 3
Waverly-Sayre quadrangles, 6
Wedel, A. A., 6
Wellsburg formation, 2, 4, 5
Whiteaves, J. F., 67
Williams, Henry Shaler, 8, 9, 10, 11, 69; (with C. L. Breger), 11, 21, 22, 57, 59, 61; (with E. M. Kindle), 5

Yale University Peabody Museum of Natural History, 3, 7, 14, 15; Division of Invertebrate Paleontology, 14; Chemung stage specimens of *Actinopteria boydi*, 28; *Cimitaria*, 64; *Cornellites chemungensis*, 37; *Cypricardella bellastriata*, 69; *Cypricardella gregaria*, 70; *Cypricardinia larocquei* n. sp., 70-71; *Edmondia philipi*, 65; *Eoschizodus chemungensis*, 67; *Glossites depressus*, 46; *Goniophora cayutensis*, n. sp., 43; *Goniophora chemungensis*, 43; *Grammatodon* (*Cosmetodon*) *chemungensis*, 25; *Grammysia elliptica*, 60; *Grammysioidea subarcuata*, 58; *Leiopteria*, 31; *Leiopteria nitida*, 30; *Leptodesma naviforme*, 33; *Leptodesma spinigerum*, 35; *Lyriopecten anomiaeformis*, 53; *Lyriopecten tricostatus*, 52; *Modiomorpha mytiloides*, 45; *Myalina newelli*, n. sp., 40; *Mytilarca chemungensis*, 39; *Nuculana*, 24; *Nuculoidea corbuliformis*, 23; *Palaeoneilo bisulcata*, 19; *Pseudaviculopecten bradfordensis*, n. sp., 51; *Pseudaviculopecten fasciculatus*, 51; *Pseudaviculopecten striatus*, 50; *Pterinopecten strictus*, 55; *Ptychodesma neglectum*, 42; *Spathella typica*, 48; *Vertumnia reversa*, 57; *Sphenotus tiogensis*, n. sp., 62

PLATES

Abbreviations used in explanations:

AMNH—The American Museum of Natural History, New York, New York, U.S.A.
NYSM—The New York State Museum, Albany, New York, U.S.A.
YPM—Peabody Museum of Natural History, Yale University, New Haven, Connecticut, U.S.A.
Loc.—Locality

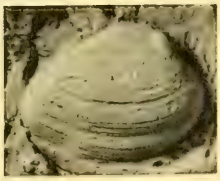
All illustrated Yale Peabody Museum specimens were collected for this study except where otherwise noted. All magnifications are given in linear (not areal) factors. All figured specimens are positive composite molds unless otherwise noted.

PLATE 1

All figures are X1.5 except fig. 9 (X5) and fig. 11 (X2.5).

Figs. 1-18. *Palaeoneilo constricta* (Conrad) ..... p. 17

1.—YPM 21301, Loc. 23B. 2.—Latex cast of YPM 21302, Loc. 27. 3.—YPM 21303, Loc. 75. 4,9,10.—YPM 21304, Loc. 38, showing impression of dentition and muscle scars. Figs. 9 and 10 are latex casts of the composite mold shown in fig. 4. 5.—YPM 21305, Loc. 66. 6.—Latex cast of YPM 21306, Loc. 38. 7.—Latex cast of YPM 21307, Loc. 34. 8.—Latex cast of YPM 21308, Loc. 33. 11.—YPM 21309, Loc. 38, dorsal view of articulated valves showing impression of dentition. 12.—YPM 21310, Loc. 38, showing impression of dentition and anterior muscle scar. 13.—YPM 21311, Loc. 30, showing impression of dentition. 14.—YPM 21312, Loc. 34. 15.—YPM 21313, Loc. 30. 16.—YPM 21314, Loc. 23B. 17.—Latex cast of YPM 21315, Loc. 38. 18.—YPM 21316, Loc. 94, showing impression of dentition.



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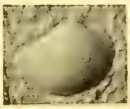

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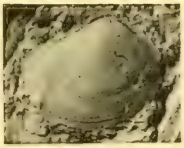

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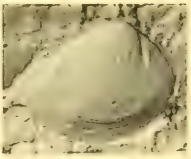

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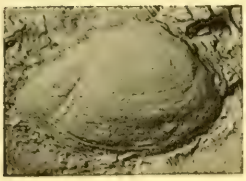

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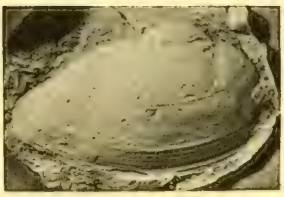

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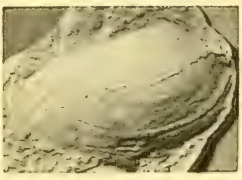

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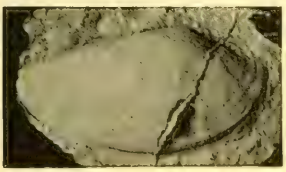

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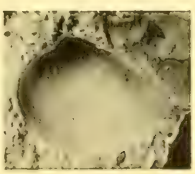

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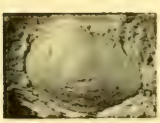

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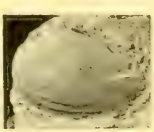

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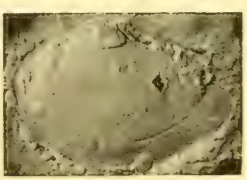

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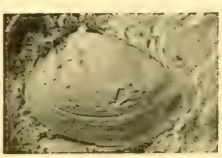

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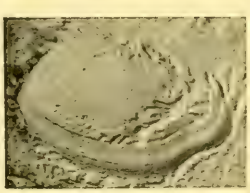

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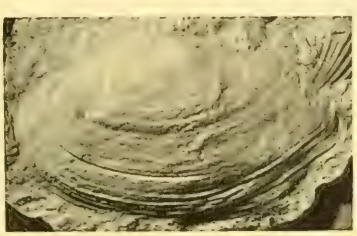

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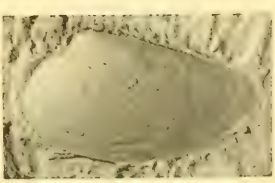

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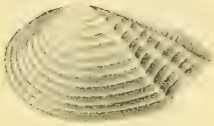

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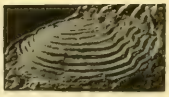

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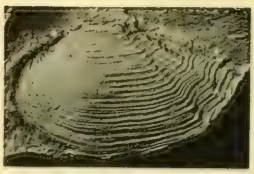

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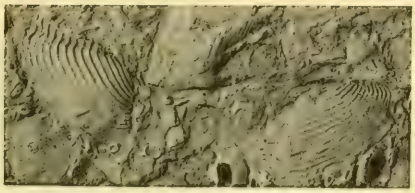

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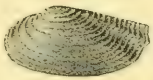

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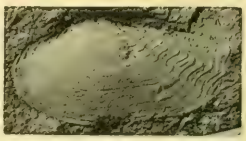

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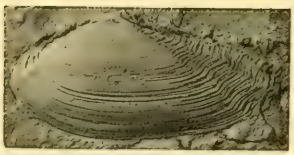

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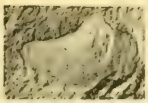

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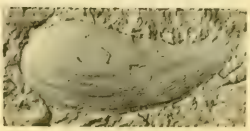

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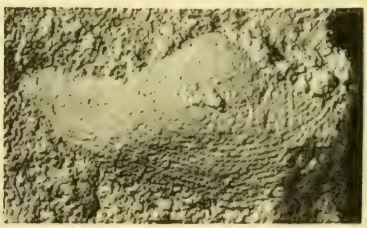

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PLATE 2

All figures are X1.5 except fig. 1 (X2), fig. 11 (X1), and figs. 17-21 (X3).

Figs. 1-10. *Palaeoneilo bisulcata* Hall and Whitfield ..... p. 19

1,2.—Hall's figure and photograph of holotype, NYSM 2918, from "near Elmira, New York," showing impression of dentition. 3.—YPM 21317, Loc. 102. 4.—YPM 21318, Loc. 35, showing impression of dentition. 5.—YPM 21319, Loc. 87, showing unusually fine sculpture. 6.—Latex cast of YPM 21320, Loc. 75. 7.—Latex cast of YPM 21321, Loc. 75. 8.—YPM 21322, Loc. 75. 9, 10.—Latex cast of YPM 21323, Loc. 23B.

Figs. 11-16. *Palaeoneilo angusta* Hall ..... p. 21

11, 12.—Original figure and photograph of holotype, NYSM 2915, from "near Elmira, New York," showing impression of dentition. 13.—Latex cast of YPM 21324, Loc. 22. 14.—YPM 21325, Loc. 102, showing impression of dentition. 15.—Latex cast of YPM 21326, Loc. 102. 16.—Latex cast of YPM 21327, Loc. 87.

Figs. 17-20. *"Nuculana" rostellata*? (Conrad) ..... p. 24

17.—YPM 21328, Loc. 102. 18.—YPM 21329, Loc. 102. 19.—YPM 21330, Loc. 102. 20.—YPM 21331, Loc. 102.

Fig. 21. *"Nuculana"* sp. ..... p. 24

21.—YPM 21332, Loc. 28.

PLATE 3

All figures are X2 except fig. 18 (X4) and figs. 21-26 (X1.5).

Figs. 1-20. *Nuculoidea corbuliformis* (Hall and Whitfield) ..... p. 22

1.—YPM 21333, Loc. 102. 2.—YPM 21334, Loc. 38. 3.—YPM 21335, Loc. 38. 4.—YPM 21336, Loc. 102. 5.—YPM 21337, Loc. 102. 6.—YPM 21338, Loc. 102. 7.—YPM 21339, Loc. 102. 8.—YPM 21340, Loc. 102. 9.—YPM 21341, Loc. 23B. 10.—YPM 21342, Loc. 38. 11.—YPM 21343, Loc. 102. 12.—YPM 21344, Loc.102. 13.—YPM 21345, Loc. 38. 14.—YPM 21346, Loc. 66. 15.—YPM 21347, Loc. 75. 16.—YPM 21348, Loc. 102. 17.—Latex cast of YPM 21349, Loc. 30. 18.—YPM 21350, Loc. 102, dorsal view of articulated valves showing obscure impression of dentition. 19.—YPM 21351, Loc. 23B, showing shape variation on a single slab. 20.—YPM 21352, Loc. 23B, showing shape variation on a single slab.

Figs. 21, 22. *Actinopteria* sp. A ..... p. 28

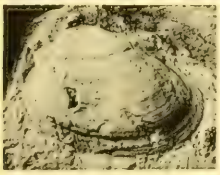
21, 22.—YPM 21353, Loc. 22. Fig. 21 is a latex cast of the predominantly external "negative" of the largely internal composite mold shown in fig. 22.

Figs. 23, 24. *Actinopteria*? sp. B ..... p. 29

23.—YPM 21354, Loc. 84. 24.—YPM 21355, Loc. 84.

Figs. 25, 26. *Actinopteria boydi* (Conrad) ..... p. 27

25.—YPM 21356 (collected by E. I. Leith), Loc. 66. 26.—YPM 21357 (collected by E. I. Leith), Loc. 66.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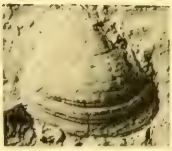
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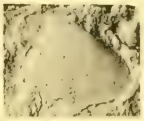
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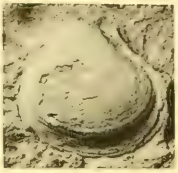
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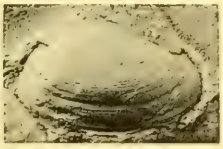
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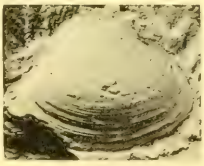
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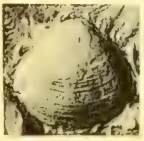
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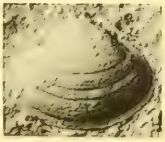
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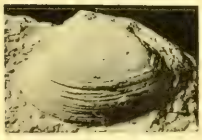
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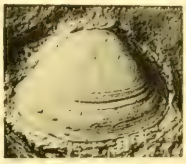
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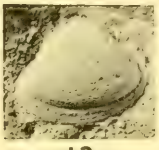
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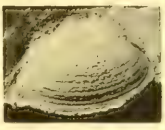
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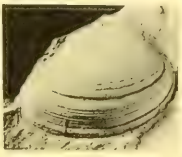
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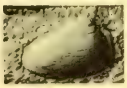
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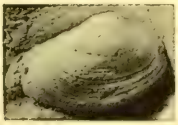
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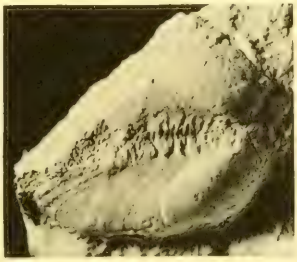
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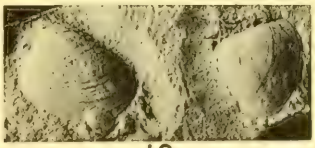
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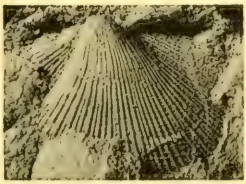
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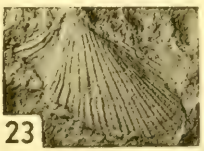
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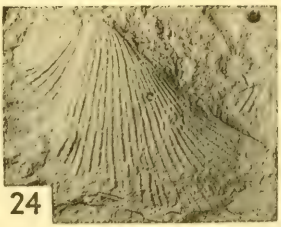
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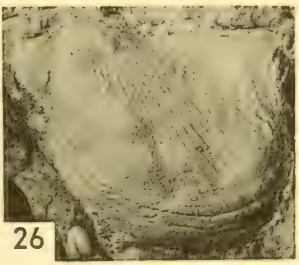
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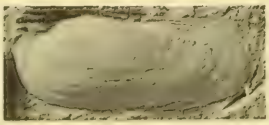

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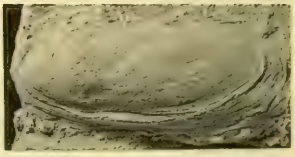

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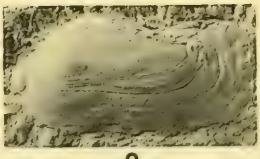

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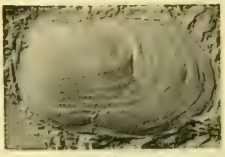

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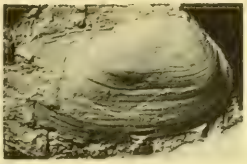

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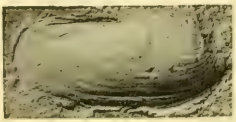

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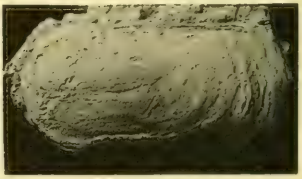

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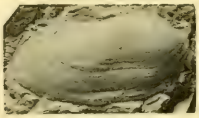

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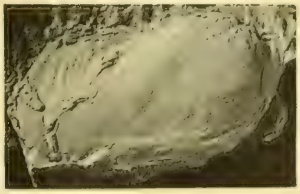

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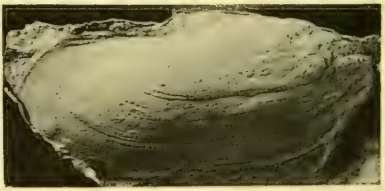

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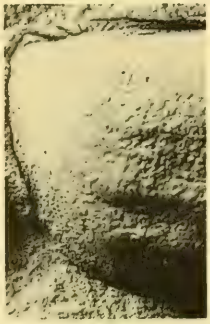

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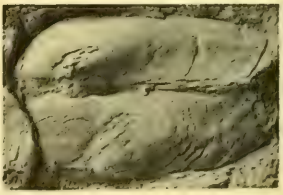

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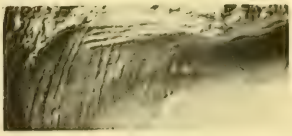

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PLATE 4

All figures are X1.5 except fig. 2 (X1) and figs. 16 and 17 (X3).

Figs. 1-20. *Grammatodon (Cosmetodon) chemungensis* (Hall and Whitfield) ..... p. 25

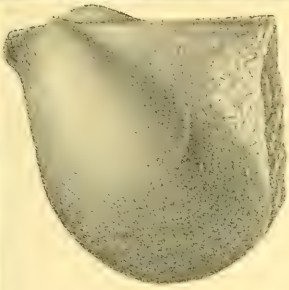
1, 2.—Photograph and Hall's figure of holotype, AMNH 6132/1:1 from "near Elmira, New York." 3.—YPM 21358, Loc. 22. 4.—YPM 21359, Loc. 75. 5.—YPM 21360, Loc. 75. 6.—YPM 21361, Loc. 75. 7, 16.—YPM 21362, Loc. 75. Fig. 16 is a latex cast of the posterior hinge impression of the specimen shown in fig. 7. 8.—YPM 21363, Loc. 75. 9.—YPM 21364, Loc. 75. 10.—YPM 21365, Loc. 75. 11.—YPM 21366, Loc. 75. 12.—YPM 21367, Loc. 75. 13.—YPM 21368, Loc. 75. 14.—YPM 21369, Loc. 75. 15.—Latex cast of YPM 21370, Loc. 87. 17.—NYSM 2706, from "near Meadville, Pennsylvania," a Cassadaga stage specimen showing the cardinal dentition, figured by Hall (1885) as fig. 16 of pl. 51. 18.—Latex cast of YPM 21371, Loc. 75, dorsal view of two articulated valves. 19.—Latex cast of YPM 21372, Loc. 75, showing three valves, two of which are articulated. 20.—YPM 21373, Loc. 75, showing shape variation on a single slab (the left valve is inverted).

PLATE 5

All figures are X1.

Figs. 1-13. *Leiopteria nitida* Hall ..... p. 29

1-4.—Original figures and photographs of the holotype, NYSM 2633, from "eight miles north of Binghamton, New York," a specimen preserving both valves, the right valve (figs. 3 and 4) being distorted by compression. 5, 6.—Original figure and photograph of the holotype of *Leiopteria linguiformis* Hall, NYSM 8870, probably from "north of Binghamton, New York." 7.—YPM 21374, Loc. 38. 8, 11.—YPM 21375, Loc. 66 (from an early YPM collection, collector unknown), an internal mold of two articulated valves. Fig. 8 is a dorsal view. The left valve of this specimen is shown in pl. 6, fig. 11. 9.—YPM 21376, Loc. 23B, showing faint impression of posterior part of ligament area. 10.—YPM 21377, Loc. 38. 12.—Latex cast of YPM 21378, Loc. 66 (from an early YPM collection, collector unknown), a slab with fragmentary left valve and well-preserved right valve. 13.—YPM 21379, Loc. 94.



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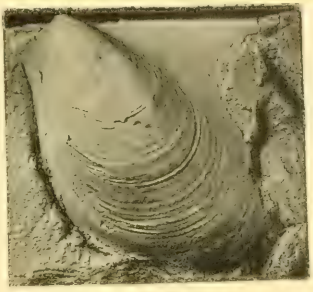

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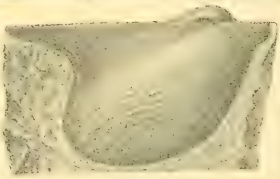

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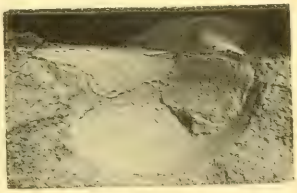

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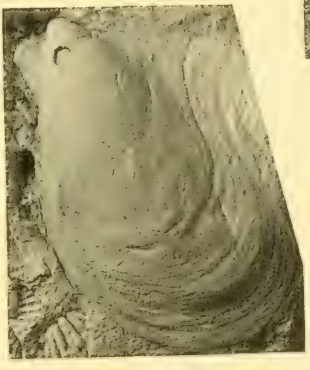

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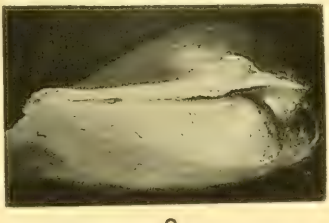

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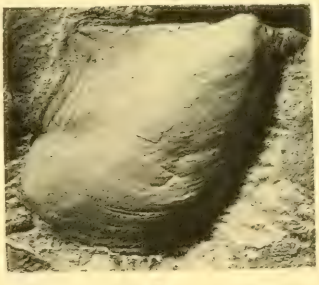

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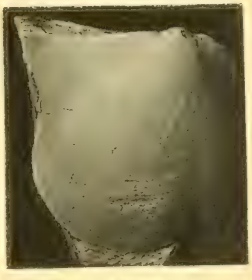

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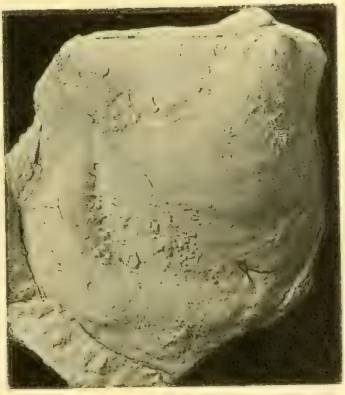

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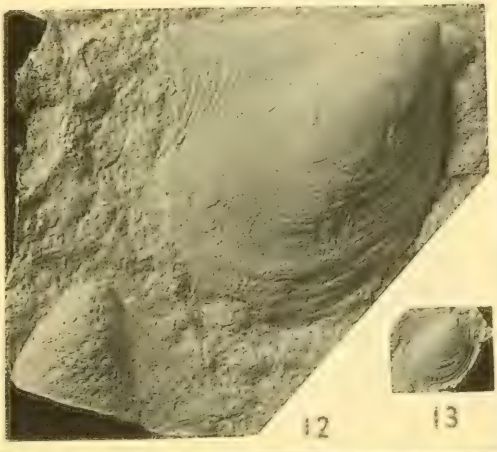

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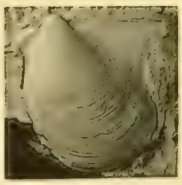

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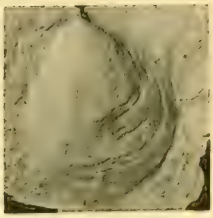

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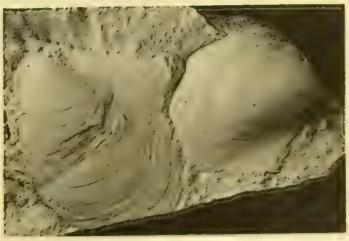

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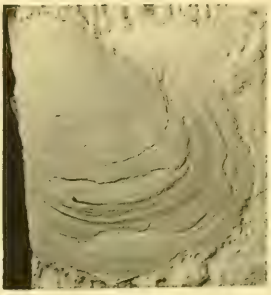

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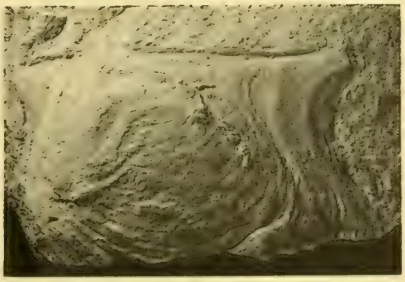

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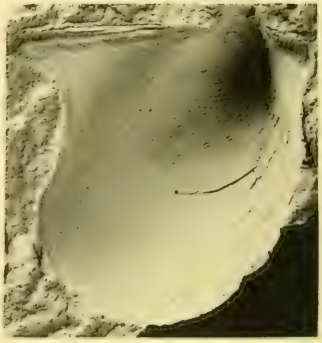

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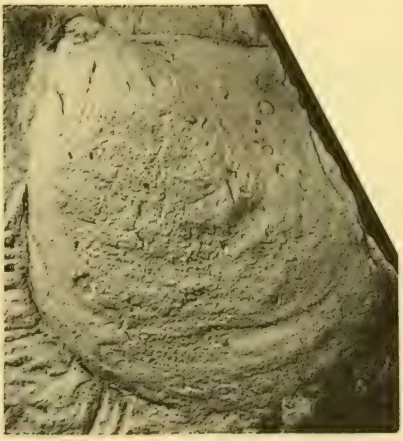

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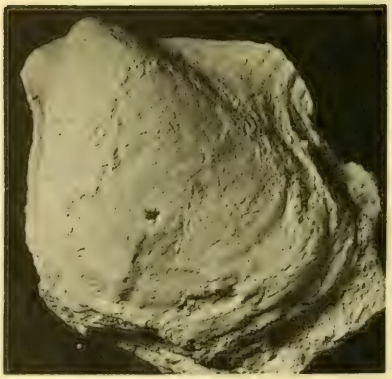

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PLATE 6

All figures are X1 except fig. 9 (X2).

Figs. 1-11. *Leiopteria nitida* Hall ..... p. 29

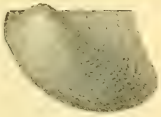
1, 9.—YPM 21380, Loc. 30. Fig. 9 is a latex cast of the specimen of fig. 1, showing original nature of lateral dentition. 2.—YPM 21381, Loc. 38. 3.—Latex cast of YPM 21382, Loc. 38. 4.—Latex cast of YPM 21383, Loc. 64. 5.—YPM 21384, Loc. 38. 6.—YPM 21385, Loc. 38. 7.—YPM 21386, Loc. 22. 8.—YPM 21387, Loc. 103, showing impression of ligament area. 10.—YPM 21388, Loc. 66 (collected by E. I. Leith). 11.—YPM 21374, Loc. 66 (from an early YPM collection, collector unknown), an internal mold. Two other views of this specimen are given in figs. 8 and 11 of pl. 5.

PLATE 7

All figures are X1.5 except fig. 1 (X1) and fig. 18. (X4/5).

Figs. 1-18. *Leptodesma naviforme* Hall ..... p. 32

1, 2.—Original figure and photograph of holotype, AMNH 6097/1:1, from "near Ithaca, New York" (probably Finger Lakes stage). 3.—YPM 21389, Loc. 38. 4.—YPM 21390, Loc. 38. 5.—YPM 21391, Loc. 38. 6.—YPM 21392, Loc. 38. 7.—YPM 21393, Loc. 38. 8.—YPM 21394, Loc. 38. 9.—YPM 21395, Loc. 38. 10.—YPM 21396, Loc. 38. 11.—YPM 21397, Loc. 30. 12.—YPM 21398, Loc. 38. 13.—YPM 21399, Loc. 30. 14.—YPM 21400, Loc. 38. 15.—YPM 21401, Loc. 38, a negative composite mold of a left valve showing the spine. 16.—YPM 21402, Loc. 30. 17.—YPM 21403, Loc. 38, dorsal view of two articulated individuals. 18.—YPM 21704, Loc. 30, showing shape variation on a single slab.



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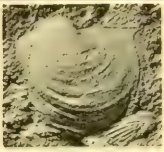

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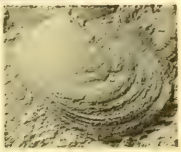

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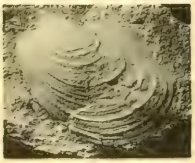

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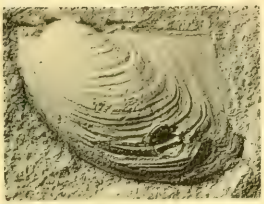

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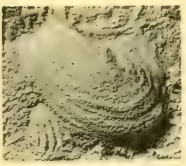

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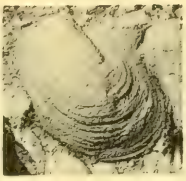

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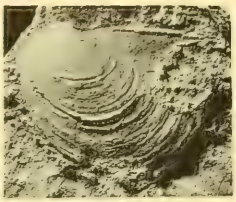

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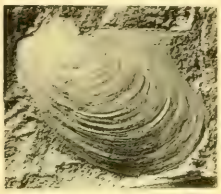

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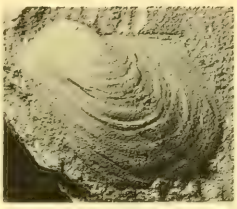

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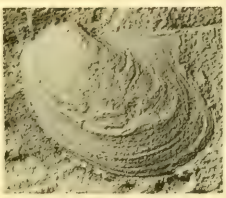

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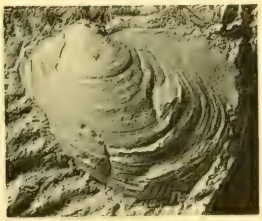

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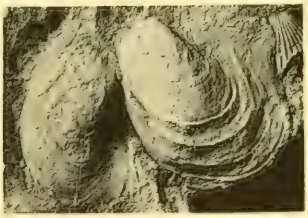

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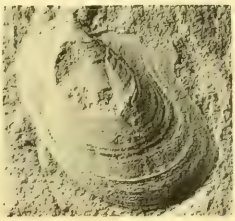

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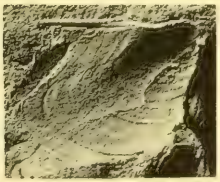

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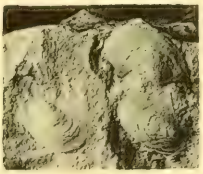

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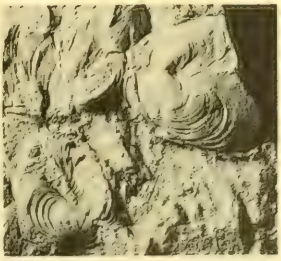

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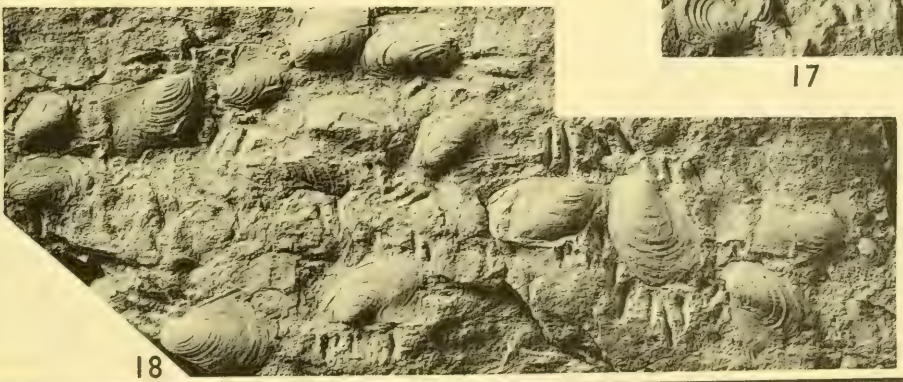

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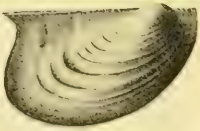

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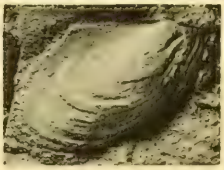

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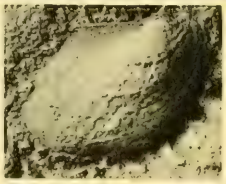

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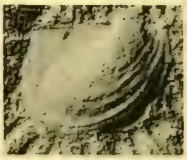

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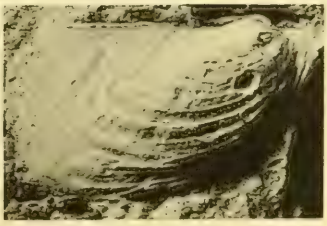

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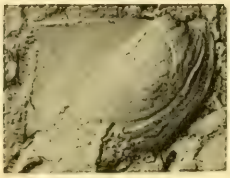

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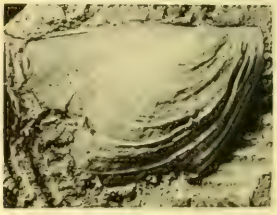

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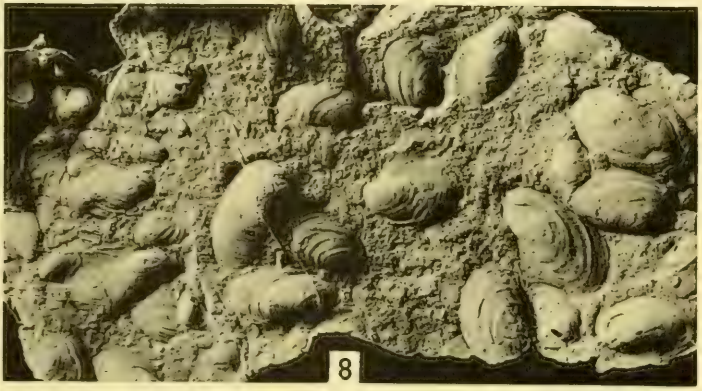

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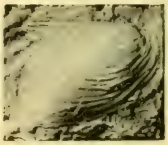

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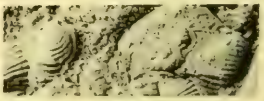

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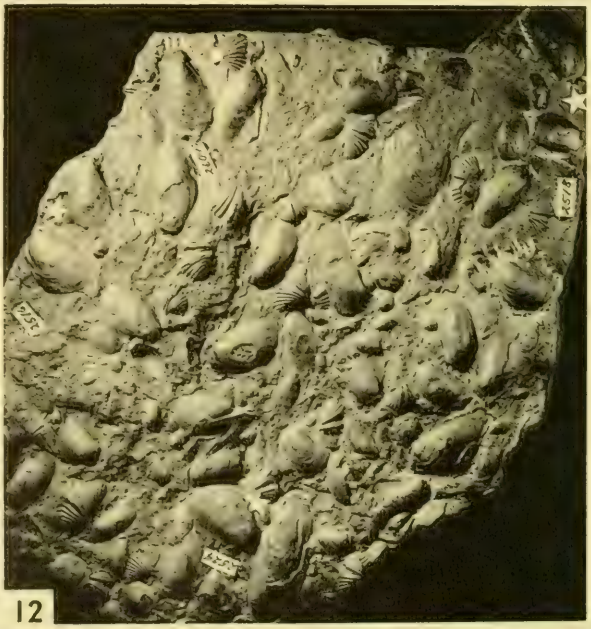

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PLATE 8

All figures are X1.5 except fig. 1 (X1), fig. 10 (X2), fig. 11 (X1), and fig. 12 (X 1/2).

Figs. 1-10. *Leptodesma naviforme* Hall ..... p. 32

1, 5.—Original figure and photograph of the paratype figured by Hall (1884c) as fig. 1 of pl. 23, AMNH 6097/1:2, from "near Ithaca, New York" (probably Finger Lakes stage). 2.—YPM 21404, Loc. 38. 3.—YPM 21405, Loc. 30. 4.—YPM 21406, Loc. 38. 6.—YPM 21407, Loc. 38. 7.—YPM 21408, Loc. 38, 8.—Latex cast of YPM 21409, Loc. 38, showing shape variation on a single slab. 9.—YPM 21410, Loc. 38. 10.—YPM 21411, Loc. 38.

Figs. 11,12. *Leptodesma spinigerum* (Conrad) ..... p. 33

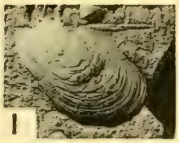
11.—YPM 21412, Loc. 102, showing four articulated individuals. 12.—NYSM 2516, 2518, 2524, 2609, from "Chemung River above Elmira, New York," showing specimens from a single Chemung stage slab figured by Hall (1884c) as *Leptodesma agassizi* (NYSM 2516, 2518; pl. 89, figs. 17, 19), *Leptodesma billingsi* (NYSM 2524; pl. 89, fig. 13), and *Leptodesma spinigerum* (NYSM 2609; pl. 89, fig. 1).

PLATE 9

All figures are X1.

Figs. 1-22. *Leptodesma spinigerum* (Conrad) ..... p. 33

The odd-numbered figures are from a single bedding plane at locality 102. The even-numbered figures are holotypes (except fig. 2) of 11 species considered here to be subjective synonyms. 1.—YPM 21413, Loc. 102. 2.—Specimen figured by Hall (1884c, pl. 21, fig. 13) as *Leptodesma spinigerum* (Conrad), AMNH 6103/1:1, from "Painted Post, Steuben County, New York." 3.—YPM 21414, Loc. 102. 4.—Holotype of *Avicula protexta* Conrad, AMNH 6099/1:1, from "Chemung River, Upper Narrows, New York." 5.—YPM 21415, Loc. 102. 6.—Holotype of *Leptodesma loxias* Hall, NYSM 2554, from "Lawrenceville, Tioga County, Pennsylvania." 7.—YPM 21416, Loc. 102. 8.—Holotype of *Leptodesma demus* Hall, NYSM 2536, from "Lawrenceville, Tioga County, Pennsylvania." 9.—YPM 21417, Loc. 102. 10.—Holotype of *Leptodesma agassizi* Hall, NYSM 2517, from "Chemung River between Elmira and Waverly, New York." 11.—YPM 21418, Loc. 102. 12.—Holotype of *Leptodesma creon* Hall, NYSM 2532, from "Lawrenceville, Tioga County, Pennsylvania." 13.—YPM 21419, Loc. 102. 14.—Holotype of *Leptodesma rogersi* Hall, NYSM 2595, from "Norwich, Chenango County, New York" (probably Finger Lakes stage). 15.—Latex cast of YPM 21420, Loc. 102. 16.—Holotype of *Avicula longispina* Hall, AMNH 6094/1:1, from "Painted Post, New York." 17.—YPM 21421, Loc. 102. 18.—Holotype of *Leptodesma robustum* Hall, AMNH 6100/1:1, from "Painted Post, New York." 19.—YPM 21422, Loc. 102. 20.—Holotype of *Leptodesma shumardi* Hall, NYSM 2602, from "between Corning and Elmira, New York." 21.—YPM 21423, Loc. 102. 22.—Holotype of *Leptodesma medon* Hall, NYSM 2562, from "Lawrenceville, Tioga County, Pennsylvania."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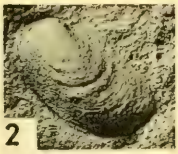
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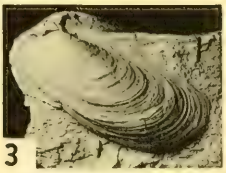
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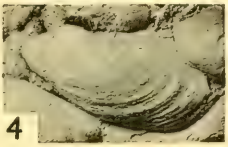
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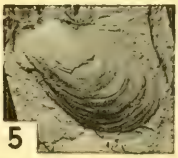
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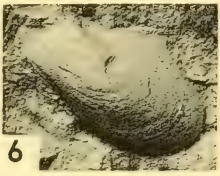
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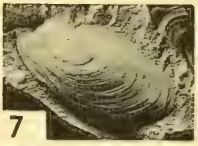
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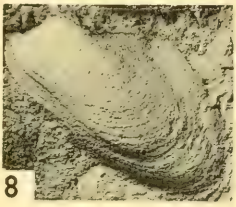
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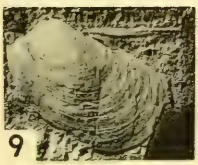
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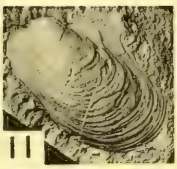
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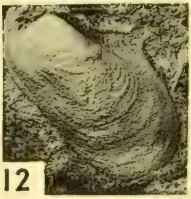
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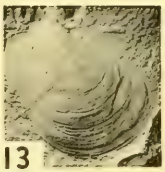
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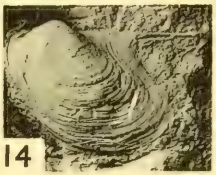
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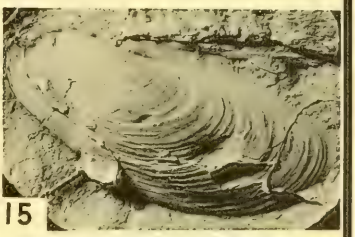
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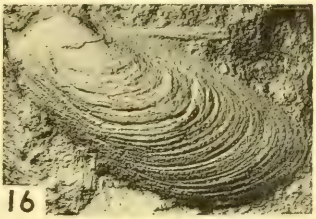
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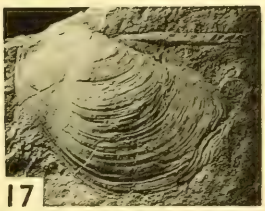
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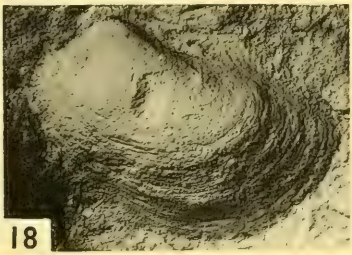
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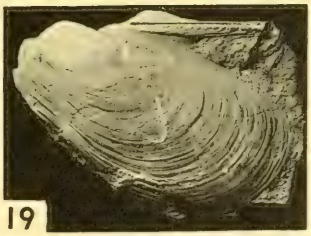
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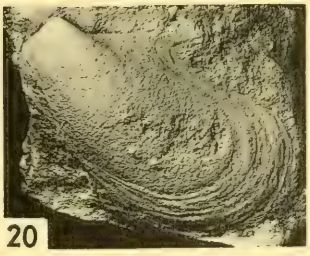
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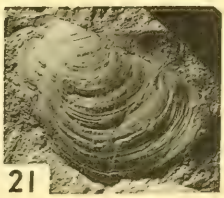
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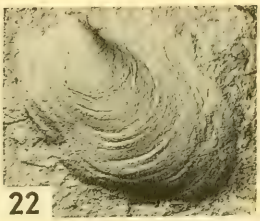
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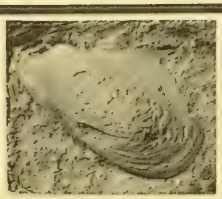
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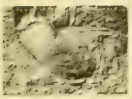
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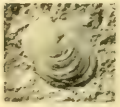
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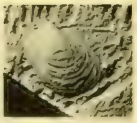
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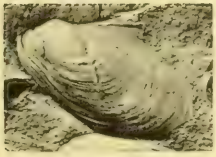
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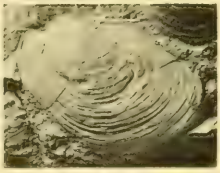
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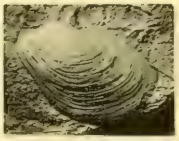
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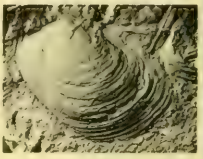
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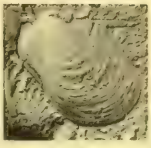
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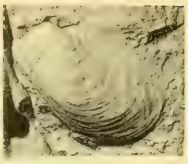
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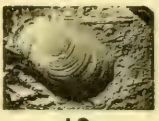
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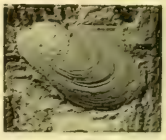
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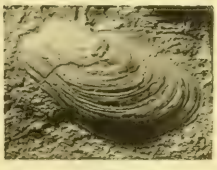
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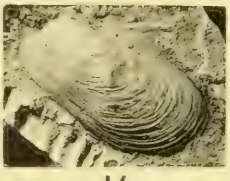
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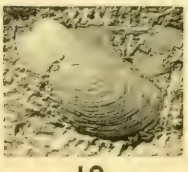
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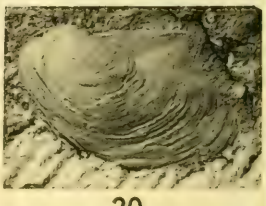
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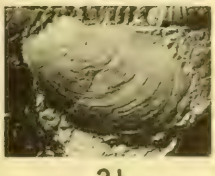
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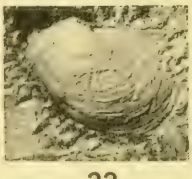
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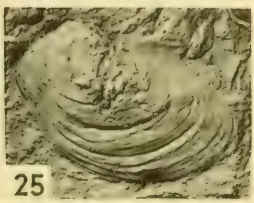
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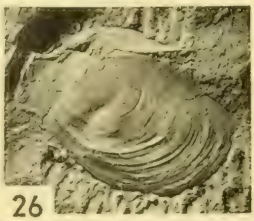
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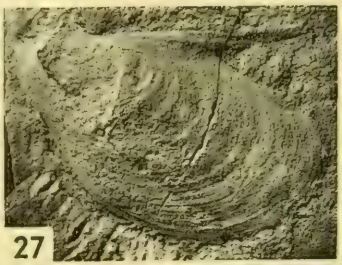
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PLATE 10

All figures are X1 except figs. 2 and 3 (X1.5).

Figs. 1-27. *Leptodesma spinigerum* (Conrad) ..... p. 33

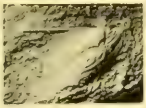
1.—Holotype of *Leptodesma becki* Hall, AMNH 6090/1:1, from "Corning, New York." 2.—YPM 21424, Loc. 102. 3.—YPM 21425, Loc. 102. 4.—YPM 21426, Loc. 102. 5.—YPM 21427, Loc. 102. 6.—YPM 21428, Loc. 102. 7.—YPM 21429, Loc. 102. 8.—YPM 21430, Loc. 102. 9.—YPM 21431, Loc. 102. 10.—YPM 21432, Loc. 102. 11.—YPM 21433, Loc. 102. 12.—YPM 21434, Loc. 102. 13.—YPM 21435, Loc. 102. 14.—YPM 21436, Loc. 102. 15.—YPM 21437, Loc. 102. 16.—YPM 21438, Loc. 102. 17.—Latex cast of YPM 21439, Loc. 102. 18.—YPM 21440, Loc. 102, showing two articulated individuals. 19.—YPM 21441, Loc. 86. 20.—YPM 21442, Loc. 103. 21.—YPM 21443, Loc. 23B. 22.—YPM 21444, Loc. 94. 23.—Latex cast of YPM 21445, Loc. 75. 24.—YPM 21446, Loc. 23B, showing two articulated valves. 25.—Latex cast of YPM 21447, Loc. 66. 26.—YPM 21448, Loc. 94. 27.—YPM 21449, Loc. 94.

PLATE 11

All figures are X1.5 except figs. 18, 20, and 21 (X1).

Figs. 1-21. *Leptodesma spinigerum* (Conrad) ..... p. 33

1.—YPM 21450, Loc. 102. 2.—YPM 21451, Loc. 102. 3.—YPM 21452, Loc. 102. 4.—YPM 21453, Loc. 102. 5.—YPM 21454, Loc. 102. 6.—YPM 21455, Loc. 102. 7.—YPM 21456, Loc. 102. 8.—YPM 21457, Loc. 102. 9.—YPM 21458, Loc. 102. 10.—YPM 21459, Loc. 102. 11.—YPM 21460, Loc. 102. 12.—YPM 21461, Loc. 102. 13.—YPM 21462, Loc. 102. 14.—YPM 21463, Loc. 102. 15.—YPM 21464, Loc. 102. 16.—YPM 21465, Loc. 102. 17.—YPM 21466, Loc. 102. 18.—YPM 21467, Loc. 94. 19.—YPM 21468, Loc. 102. 20.—YPM 21469, Loc. 94; the very fine reticulate surface pattern is an impression of an encrusting bryozoan. 21.—YPM 21470, Loc. 66.



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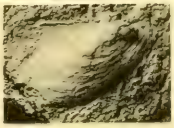

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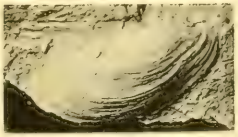

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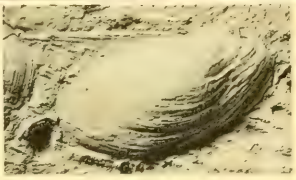

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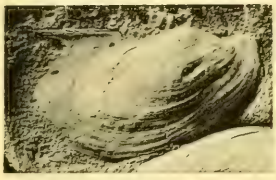

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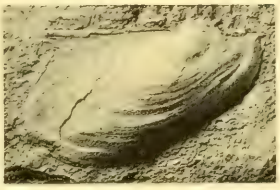

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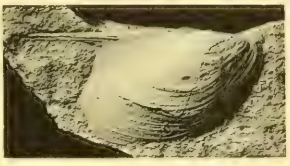

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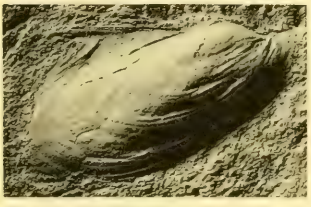

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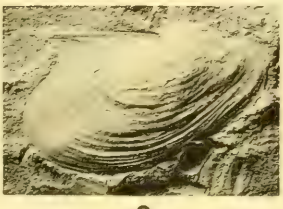

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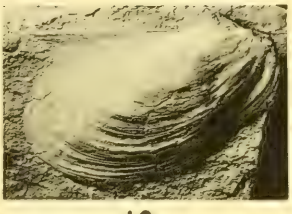

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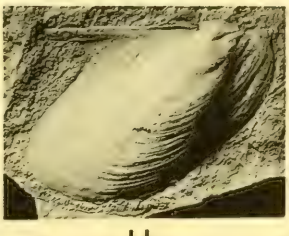

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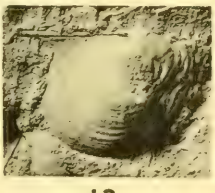

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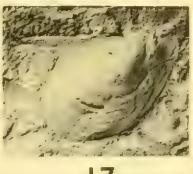

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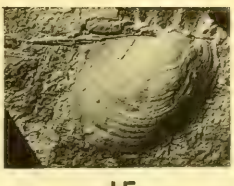

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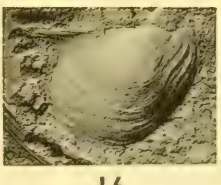

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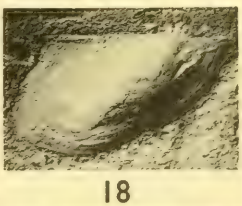

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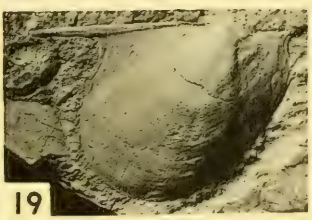

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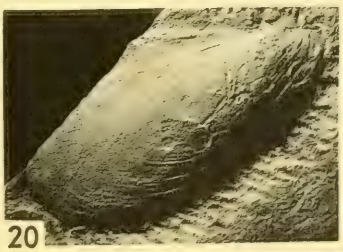

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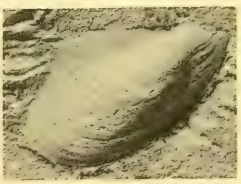

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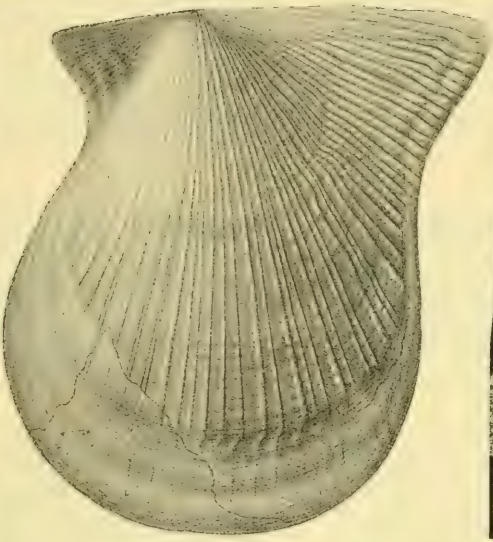

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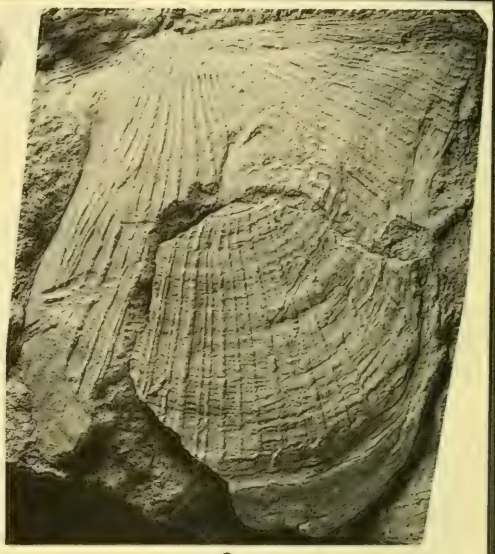

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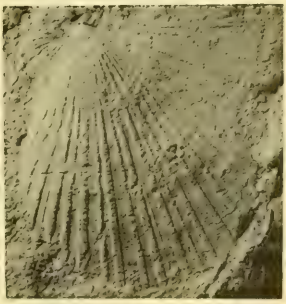

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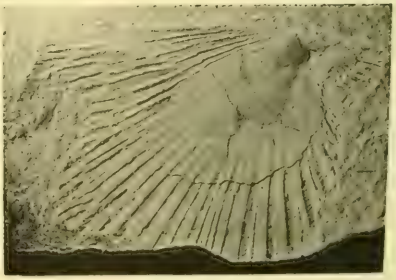

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PLATE 12

All figures are X1.

Figs. 1-6. *Cornellites chemungensis* (Conrad) ..... p. 36

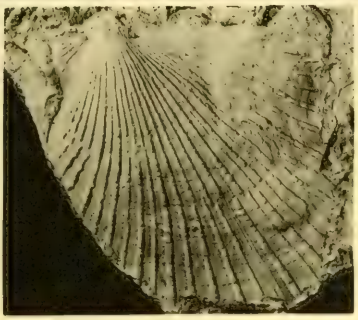
1, 2.—Hall's (1884) figure and photograph of holotype of *Avicula pecteniformis* Hall, AMNH 6073/2, from "Chemung Narrows, New York," showing impression of grooved ligament area. 3.—Holotype of *Pterinea rigida* Hall, AMNH 6080/2, from "Chemung, New York." 4.—Holotype of *Pterinea prora* Hall, AMNH 6079/1:1, from "near Elmira, New York," a negative composite mold of a left valve preserving part of the right valve as a superimposed positive composite mold. 5.—Holotype of *Pterinea consimilis* Hall, AMNH 6076/1:1, from "near Elmira, New York." 6.—Holotype of *Pterinea interstrialis* Hall, NYSM 3044, from "Chemung Narrows, New York."

PLATE 13

All figures are X1.

Figs. 1-7. *Cornellites chemungensis* (Conrad) ..... p. 36

1.—YPM 21471, Loc. 72. 2.—Latex cast of YPM 21472, Loc. 53, the slab from which this cast was taken is shown in fig. 9 of pl. 14. 3.—YPM 21473, Loc. 22. 4.—YPM 21474, Loc. 23A. 5.—YPM 21475, Loc. 66. 6.—YPM 21476 (collected by E. I. Leith), Loc. 66. 7.—Latex cast of YPM 21477, Loc. 22.



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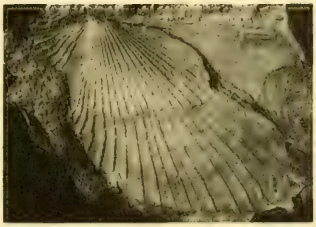

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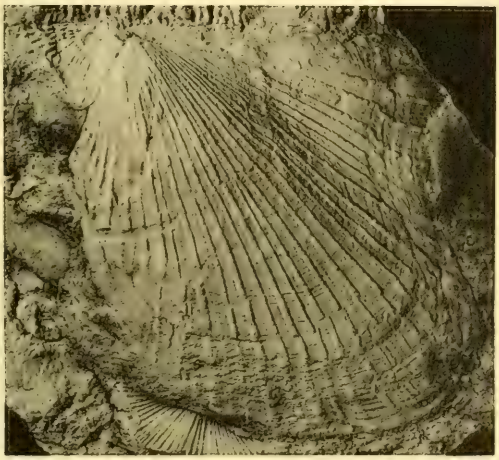

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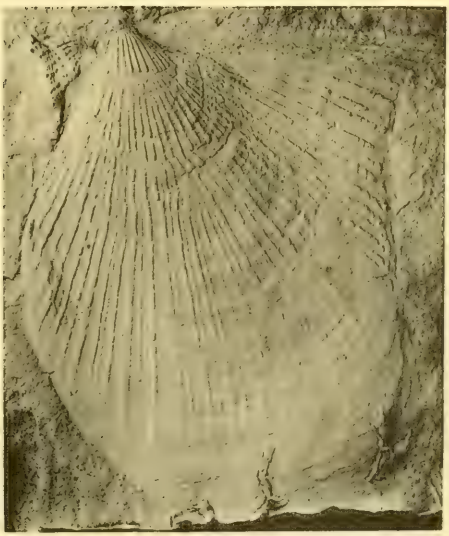

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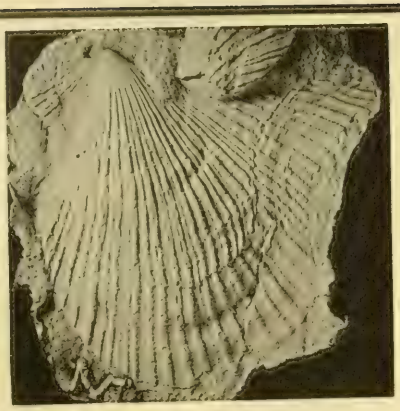

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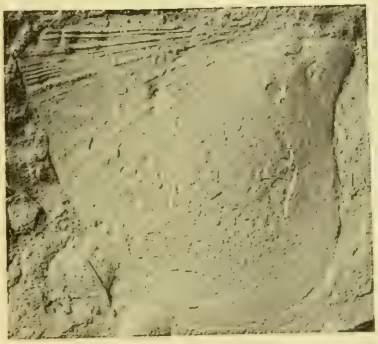

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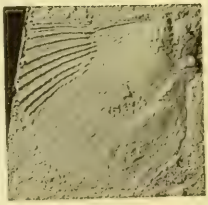

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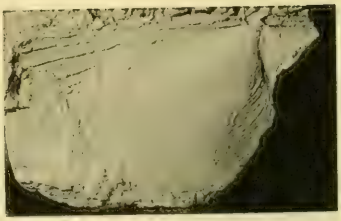

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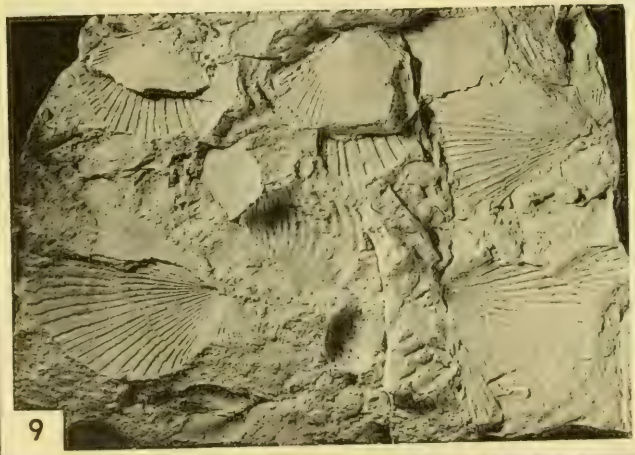

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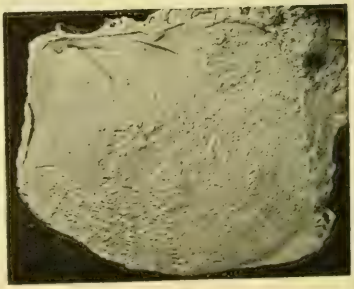

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PLATE 14

All figures are X1 except fig. 2 (X2), fig. 6 (X1.5), and fig. 9 (X3/4).

Figs. 1-9. *Cornellites chemungensis* (Conrad) ..... p. 36

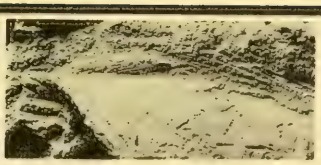
1.—Latex cast of YPM 21478 (collected by R. Howell), from "Nichols, Tioga County, New York," (probably from a glacial boulder). 2.—Latex cast of YPM 21479, Loc. 53, a fragment of the anterior hinge region of a right valve showing the grooved ligament area. The view is looking at the interior side of the right valve. 3.—YPM 21480 (collected by E. I. Leith), Loc. 66. 4.—YPM 21481, Loc. 53. 5.—Latex cast of YPM 21482, Loc. 22, showing impression of the grooved ligament area. 6, 8.—A paratype of *Pterinea consimilis* figured by Hall (1884c) as fig. 23 of pl. 84, NYSM 3033, from "Nichols, Tioga County, New York," (probably from a glacial boulder). Fig. 8 shows the entire specimen which is an internal mold of a left valve preserving impressions of the dentition and some much altered original shell material in the posterior and ventral regions. Fig. 6 is a latex cast of the hinge region showing the original nature of the cardinal and posterior dentition. 7.—YPM 21483 (collected by R. Howell), from "Nichols, Tioga County, New York," (probably from a glacial boulder). 9.—YPM 21472, Loc. 53, a slab showing two articulated individuals (at top). The cast shown in fig. 2 of pl. 13 was taken from the negative composite mold at the lower left.

PLATE 15

All figures are X1 except figs. 1, 4, 6, and 13 (X2).

Figs. 1-18. *Mytilarca chemungensis* (Conrad) ..... p. 38

1, 2.—Holotype of *Mytilarca carinata* Hall, AMNH 6109/2:1, from "near Elmira, New York." Fig. 1 is an enlargement of the hinge region showing the obscure impression of the grooved ligament area. 3.—A previously unfigured specimen from Hall's collection, AMNH 6108/1:1, from "near Elmira, New York." 4-7.—Photographs and original figures of the specimen showing the cardinal and posterior dentition figured by Hall (1884c) as fig. 19 of pl. 32 and fig. 8 of pl. 33, AMNH 6109/2:2, from "near Elmira, New York." 8.—YPM 21484, Loc. 75. 9.—YPM 21485, Loc. 75. 10.—YPM 21486, Loc. 75. 11.—YPM 21487 (collected by E. I. Leith), Loc. 22. 12.—YPM 21488, Loc. 22. 13, 14.—Latex cast of YPM 21489, Loc. 103. Fig. 13 is an enlargement of the hinge region showing the obscure impression of the grooved ligament area. 15.—YPM 21490, Loc. 75. 16.—YPM 21491, Loc. 75. 17.—The specimen figured by Hall (1884c) as fig. 17 of pl. 32, AMNH 6109/1:1, from "near Elmira, New York." 18.—YPM 21492, Loc. 75.



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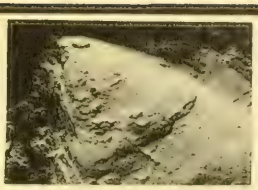

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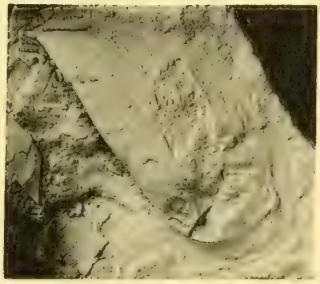

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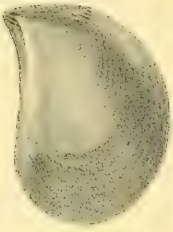

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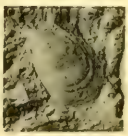

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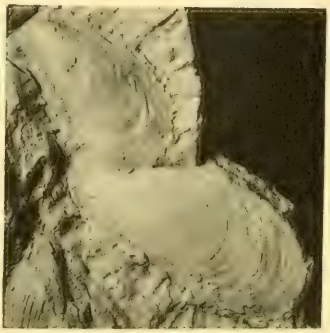

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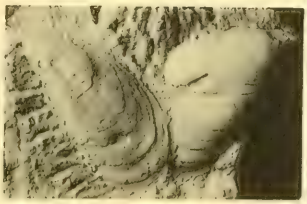

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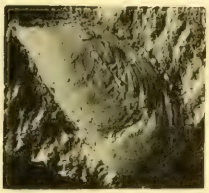

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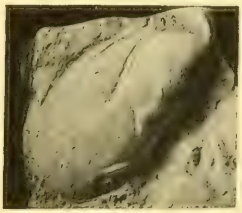

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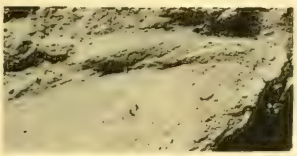

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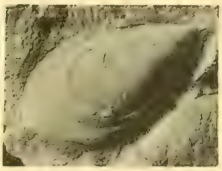

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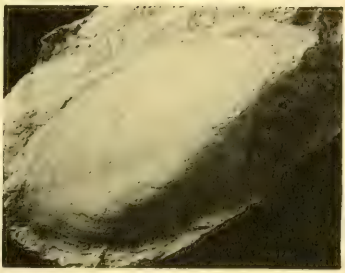

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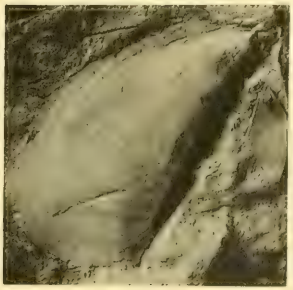

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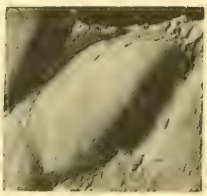

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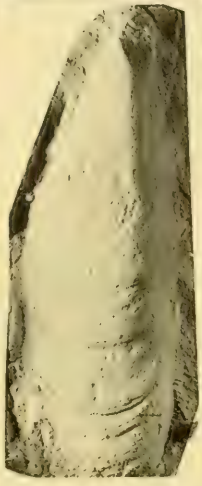

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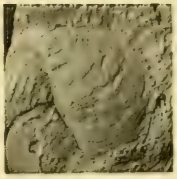

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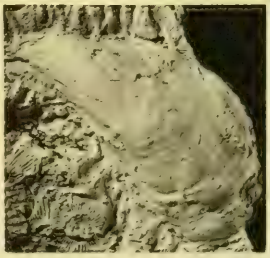

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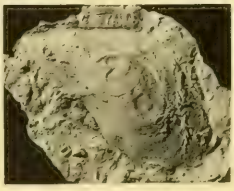

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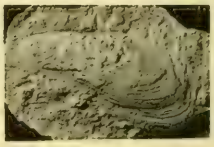

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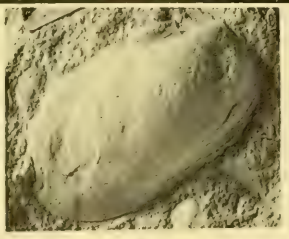

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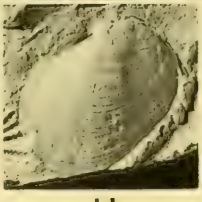

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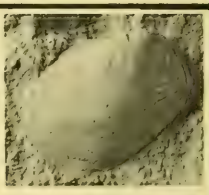

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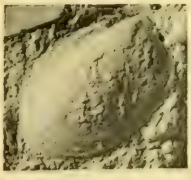

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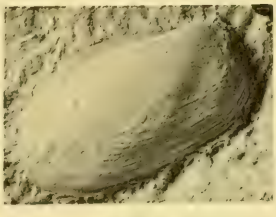

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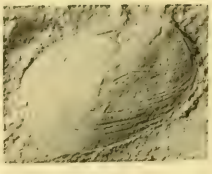

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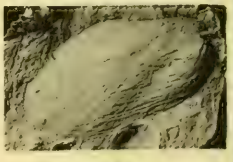

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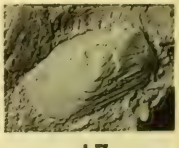

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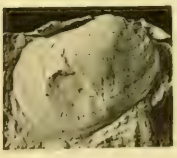

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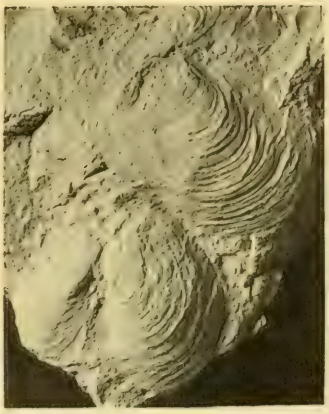

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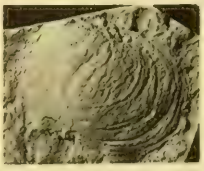

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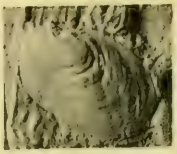

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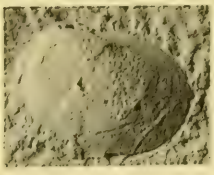

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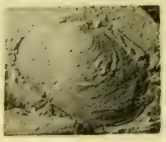

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PLATE 16

All figures are X1.5 except figs. 1-7 and 9 (X1).

Fig. 1. *Mytilarca chemungensis* (Conrad) ..... p. 38

1.—Holotype of *Mytilarca attenuata* Hall and Whitfield, NYSM 2824, from "Elmira, New York," probably from a glacial boulder.

Figs. 2-5. *Myalina? newelli,* n. sp. ..... p. 40

2.—Latex cast of holotype, YPM 21493, Loc. 23A; the large extension at the lower right is not original but was caused by a crack in the negative mold from which the cast was taken. 3.—YPM 21494, Loc. 53. 4.—YPM 21495, Loc. 53. 5.—Latex cast of YPM 21496, Loc. 34.

Fig. 6. *Myalina?* sp. ..... p. 41

6.—Latex cast of YPM 21502, Loc. 87.

Figs. 7-23. *Ptychodesma neglectum* (Hall) ..... p. 41

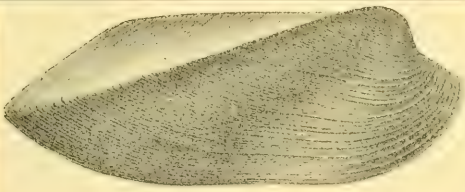
7, 8.—Original figure and photograph of holotype, AMNH 6136/1, from "near Elmira, New York." 9, 10.—Original figure and photograph of holotype of *Ptychodesma minor* Hall, AMNH 6133/2, from "near Elmira, New York." 11.—YPM 21503, Loc. 75. 12.—Latex cast of YPM 21504, Loc. 87. 13.—YPM 21505, Loc. 66. 14.—YPM 21506, Loc. 75. 15.—Latex cast of YPM 21507, Loc. 75. 16.—Latex cast of YPM 21508, Loc. 75. 17.—YPM 21509, Loc. 75. 18.—YPM 21510, Loc. 75, showing two articulated individuals. 19.—YPM 21511, Loc. 75. 20.—YPM 21512, Loc. 22. 21.—YPM 21513, Loc. 75. 22.—YPM 21514, Loc. 75. 23.—YPM 21515, Loc. 75.

PLATE 17

All figures are X1.

Figs. 1-11. *Goniophora chemungensis* (Vanuxem) ..... p. 42

1, 2.—Hall's figure and photograph of holotype, NYSM 2407, from "Owego, New York." 3.—YPM 21516, Loc. 30. 4.—YPM 21517, Loc. 38. 5.—YPM 21518, Loc. 30. 6.—YPM 21519, Loc. 38. 7.—YPM 21520, Loc. 38. 8.—YPM 21521, Loc. 38. 9.—YPM 21522, Loc. 38, showing shape variation on a single slab. 10.—YPM 21523, Loc. 33. 11.—YPM 21524, Loc. 73.



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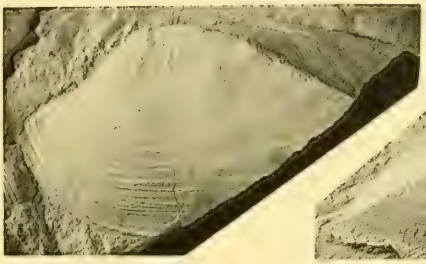

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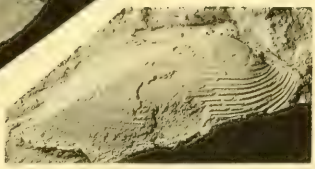

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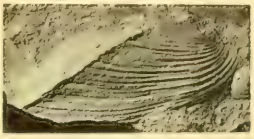

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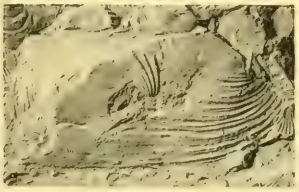

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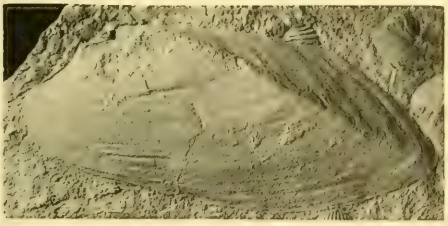

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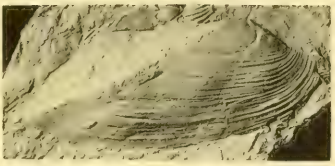

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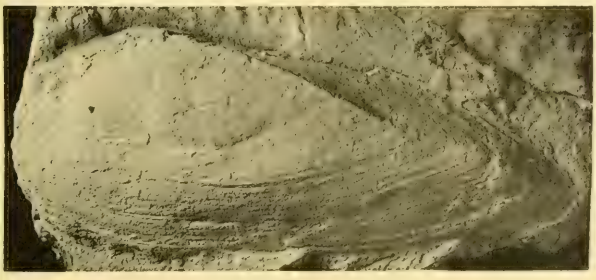

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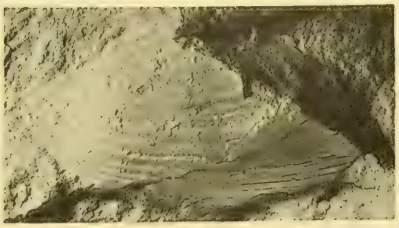

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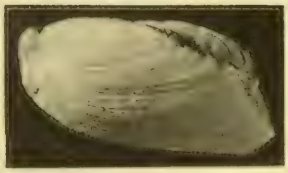

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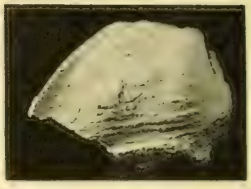

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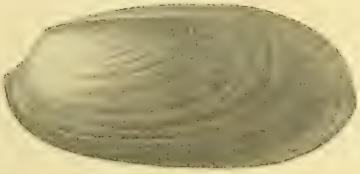

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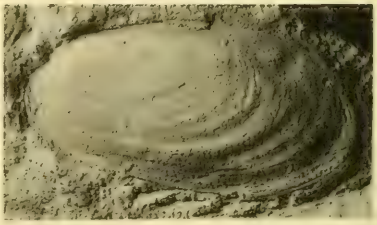

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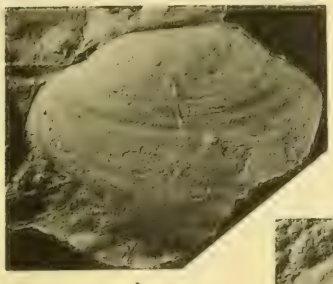

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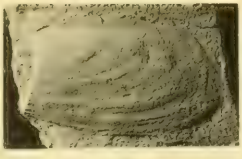

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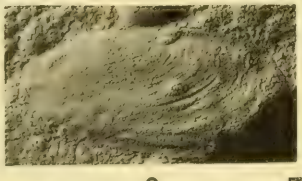

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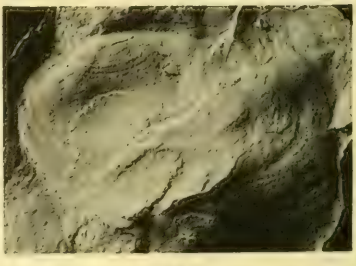

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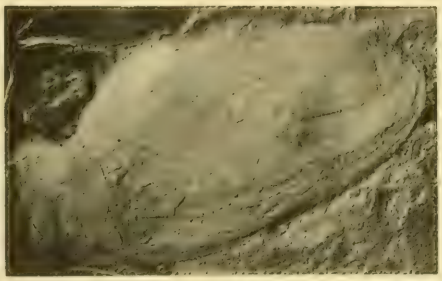

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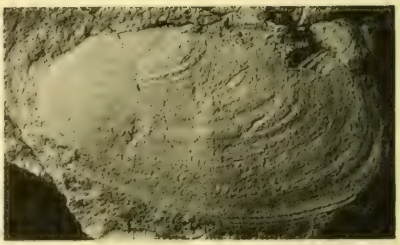

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PLATE 18

All figures are X1 except figs. 1-3 (X1.5).

Figs. 1, 2. *Goniophora cayutensis,* n. sp. ..... p. 43

1, 2.—Holotype, a specimen preserving both valves in articulation, YPM 21525, Loc. 65. Fig. 2 is a dorsal view showing the prominent escutcheon.

Fig. 3. *Goniophora* sp. ..... p. 44

3.—YPM 21527, Loc. 66.

Figs. 4-13. *Glossites depressus* Hall ..... p. 46

4, 5.—Original figure and photograph of holotype, AMNH 6178/1, from "near Elmira, New York." 6.—Latex cast of YPM 21528, Loc. 66, showing anterior muscle scar impression. 7.—YPM 21529, Loc. 22. 8.—YPM 21530, Loc. 66. 9.—Latex cast of YPM 21531, Loc. 66. 10.—Latex cast of YPM 21532, Loc. 66. 11.—Latex cast of YPM 21533, Loc. 66. 12.—The specimen shown by Hall (1885) as fig. 15 of pl. 40, NYSM 2377, from "near Elmira, New York." 13.—YPM 21534, Loc. 96, showing a faint impression of the anterior muscle scar and a possible ligament groove.

PLATE 19

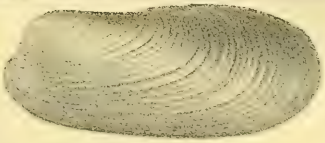
All figures are X1 except fig. 3 (X2).

Figs. 1-13. *Spathella typica* Hall ..... p. 47

1, 2.—Original figure and photograph of the holotype, AMNH 6177/1:1, from "Chemung County, New York." 3.—YPM 21535, Loc. 75. 4.—YPM 21536, Loc. 33. 5.—Latex cast of YPM 21537, Loc. 75. 6.—Latex cast of YPM 21538, Loc. 23A. 7.—Latex cast of YPM 21539, Loc. 86. 8.—YPM 21540, Loc. 75. 9.—Latex cast of YPM 21541, Loc. 22. 10.—Latex cast of YPM 21542, Loc. 34. 11.—YPM 21543, Loc. 66. 12.—YPM 21544, Loc. 22. 13.—YPM 21545, Loc. 87.

Figs. 14-16. *Modiomorpha mytiloides* (Conrad) ..... p. 45

14.—YPM 21546 (collected by E. I. Leith), Loc. 66. 15.—YPM 21547 (collected by E. I. Leith), Loc. 66. 16.—YPM 21548 (collected by E. I. Leith), Loc. 66.



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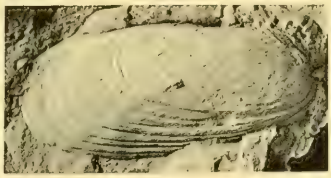

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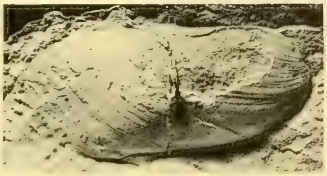

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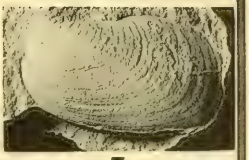

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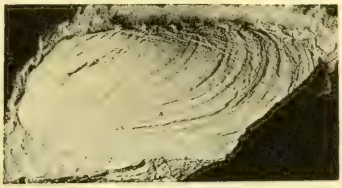

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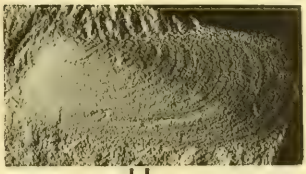

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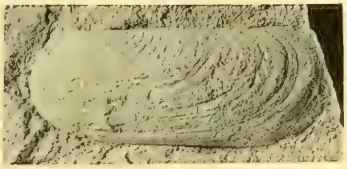

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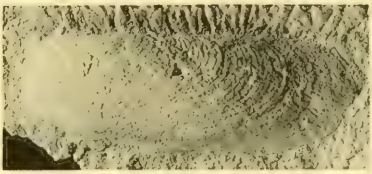

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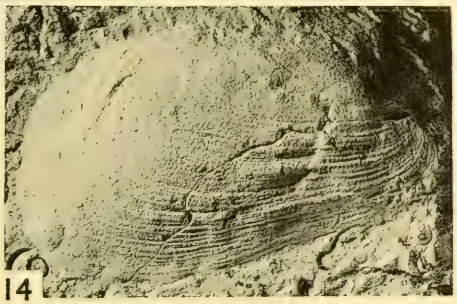

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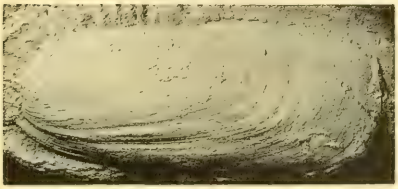

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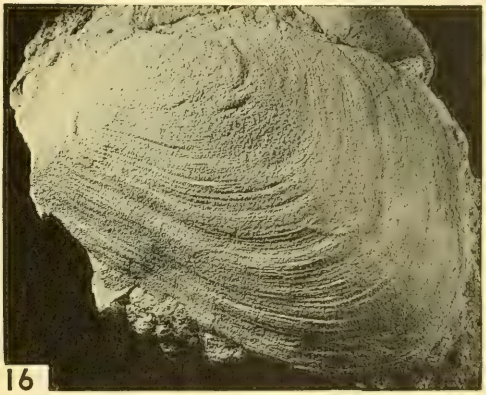

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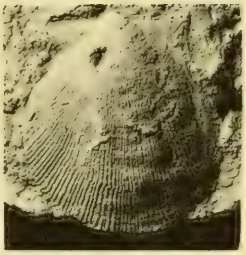

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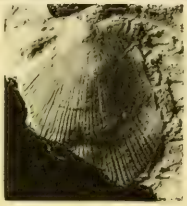

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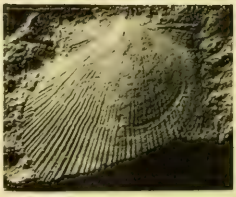

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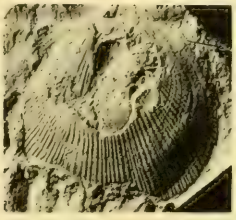

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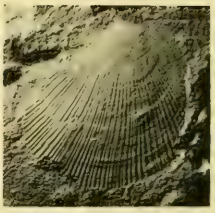

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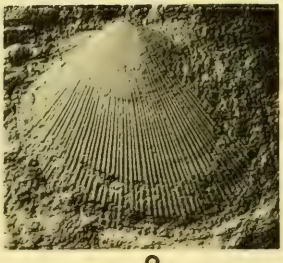

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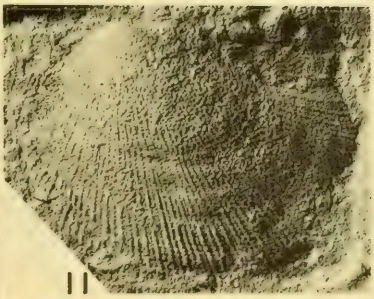

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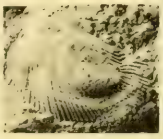

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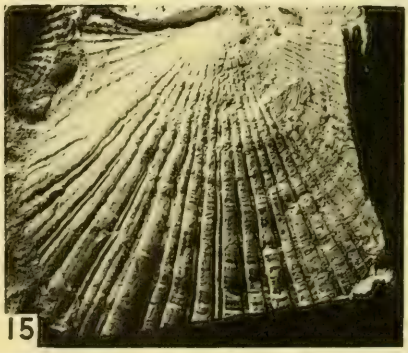

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PLATE 20

All figures are X1.5 except figs. 1, 14, and 15 (X1).
All are probably left valves except fig. 14.

Figs. 1-10. *Pseudaviculopecten striatus* (Hall) ..... p. 49

1, 2.—Hall's (1884) figure and photograph of holotype, AMNH 6058/1, from "Painted Post, Steuben County, New York." 3.—YPM 21549, Loc. 75. 4.—YPM 21550, Loc. 23B. 5.—YPM 21551, Loc. 23B. 6.—YPM 21552, Loc. 75. 7.—YPM 21553, Loc. 75. 8.—Holotype of *Aviculopecten plenus* Hall, NYSM 2273, from "near Elmira, New York." 9.—YPM 21554, Loc. 66. 10.—YPM 21555, Loc. 66.

Figs. 11-13. *Pseudaviculopecten fasciculatus* (Hall) ..... p. 50

11.—YPM 21556 (collected by E. I. Leith), Loc. 66. 12.—YPM 21557, Loc. 72. 13.—YPM 21558 (collected by E. I. Leith), Loc. 66.

Figs. 14, 15. *Pseudaviculopecten bradfordensis,* n. sp. ..... p. 51

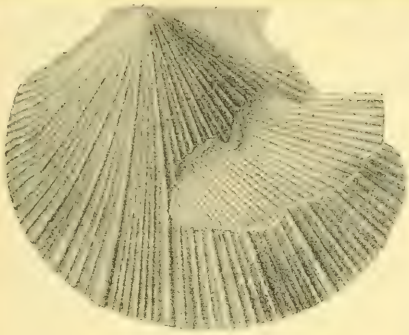
14.—Holotype, YPM 21559, Loc. 96. 15.—YPM 21560 (collected by E. I. Leith), Loc. 66.

PLATE 21

All figures are X1.

Figs. 1-8. *Lyriopecten tricostatus* (Vanuxem) ..... p. 52

1, 2.—Hall's figure and photograph of probable holotype, NYSM 2705, from "Barker Station, Broome County, New York" (probably Finger Lakes stage). 3.—YPM 21561, Loc. 75. 4.—The specimen shown by Hall (1884c) as fig. 11 of pl. 48, AMNH 6064/1:1, from "Chemung County, New York." 5.—The specimen shown by Hall (1884c) as fig. 7 of pl. 10, AMNH 6064/1:2, from "near Elmira, New York," showing faint impression of grooved ligament area. 6.—The specimen shown by Hall (1884c) as fig. 6 of pl. 10, AMNH 6064/3, from "Big Flats, Chemung County, New York" (probably from a glacial boulder), showing faint impression of grooved ligament area. 7.—A previously unfigured specimen from Hall's collection, AMNH 6064/1:3, from "Upper Narrows, Chemung County, New York." 8.—The specimen shown by Hall (1884c) as fig. 12 of pl. 10, AMNH 6064/2, from "Upper Chemung Narrows, Chemung County, New York."



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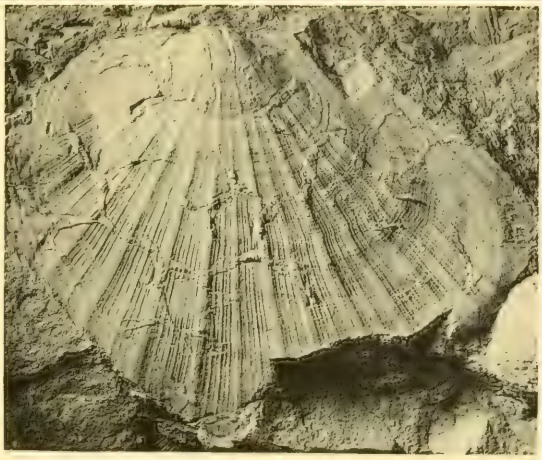

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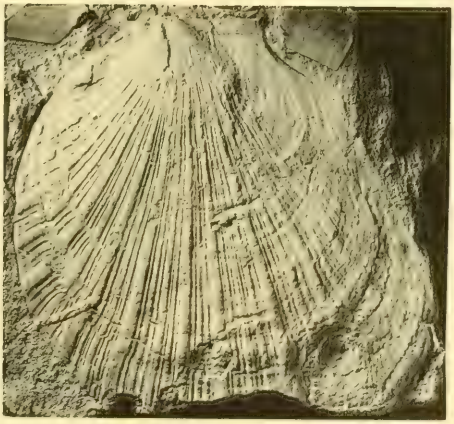

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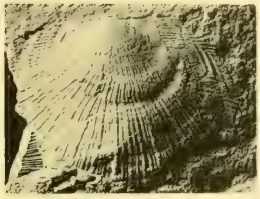

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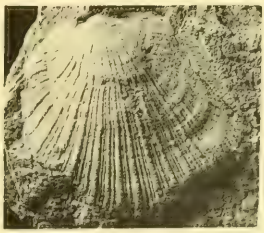

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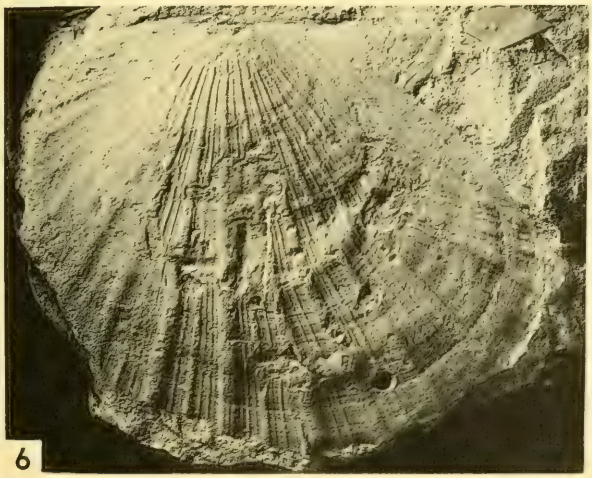

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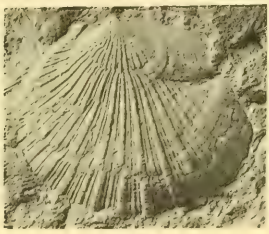

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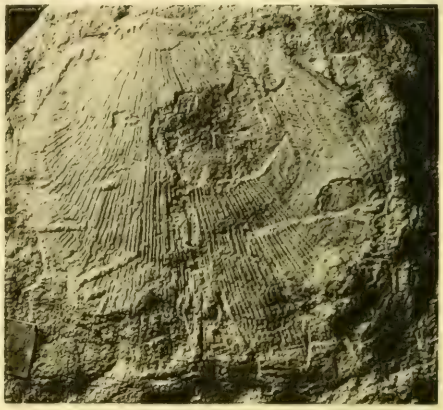

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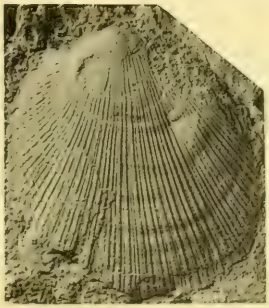

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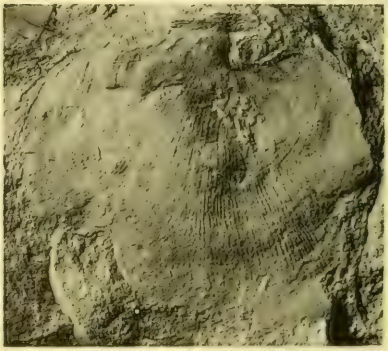

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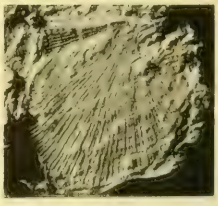

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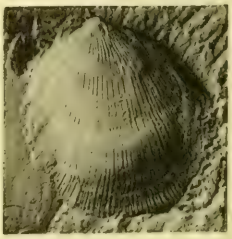

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PLATE 22

All figures are X1. All are probably left valves except figs. 5 and 6.

Figs. 1-7. *Lyriopecten anomiaeformis* Hall ..... p. 53

1, 2.—Original figure and photograph of holotype, AMNH 6060/1, from "Chemung Creek, New York." 3.—YPM 21562, Loc. 34. 4.—Latex cast of YPM 21563, Loc. 23A. 5.—The specimen shown by Hall (1884c) as fig. 10 of pl. 10. AMNH 6060/2, from "Chemung River, Upper Narrows, New York," a fragmentary right valve showing byssal notch and obscure impression of grooved ligament area. 6.—Latex cast of YPM 21564, Loc. 34, a right valve showing byssal notch. 7.—YPM 21565 (collected by E. I. Leith), Loc. 48.

Fig. 8. *Lyriopecten tricostatus* (Vanuxem) ..... p. 52

8.—Holotype of *Lyriopecten cymbalon* Hall, AMNH 6061/1, from a "boulder near Elmira, New York."

PLATE 23

All figures are X1 except fig. 11 (X3/4).

Figs. 1-8. *Pterinopecten strictus* Hall ..... p. 55

1, 3 (upper), 4.—Original figure and photographs of holotype, NYSM 3082, from "near Elmira, New York." Fig. 4 is a latex cast of the original negative composite mold shown in fig. 3. 2, 3(lower).—Original figure (Hall, 1884c, pl. 24, fig. 2) and photograph of right valve on same slab as the holotype, probably the original right valve of the holotype. 5.—YPM 21566, Loc. 75. 6.—YPM 21567, Loc. 103. 7.—Latex cast of YPM 21568, (collected by E. I. Leith), Loc. 21, a fragmentary right valve. 8.—Latex cast of YPM 21569, Loc. 103, a fragmentary right valve.

Figs. 9, 10. *Pterinopecten suborbicularis* (Hall) ..... p. 55

9.—Latex cast of YPM 21570, Loc. 76. 10.—Latex cast of YPM 21571, Loc. 76.

Fig. 11. *Lyriopecten magnificus* Hall ..... p. 54

11.—Latex cast of holotype, NYSM 2697, from "Montrose, Pennsylvania."

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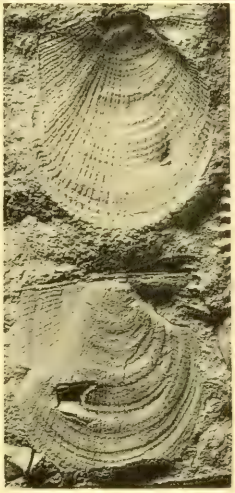

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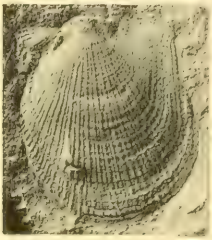

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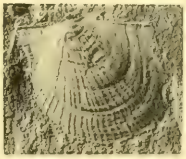

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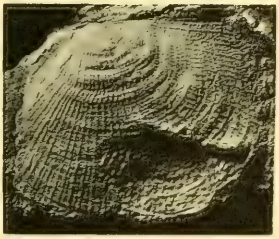

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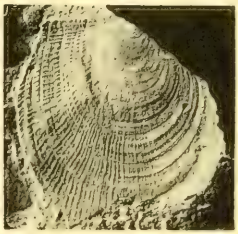

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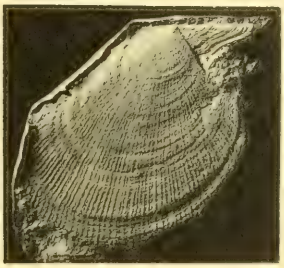

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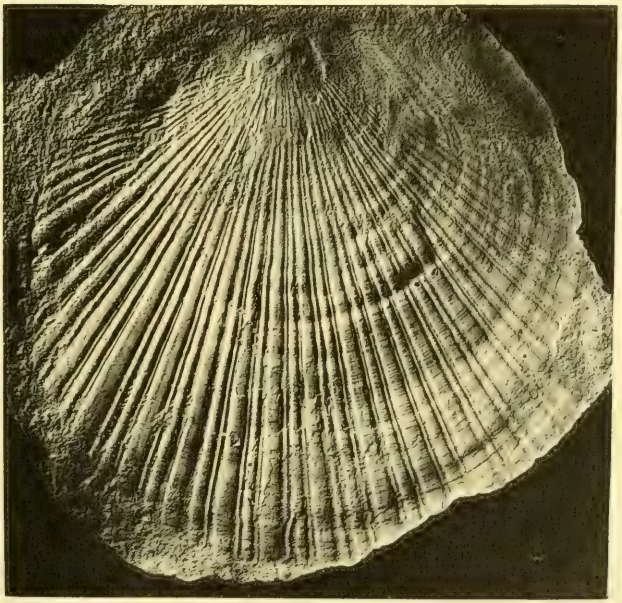

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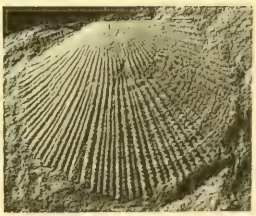

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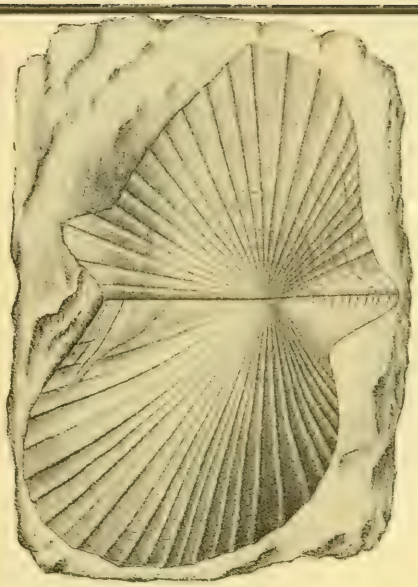

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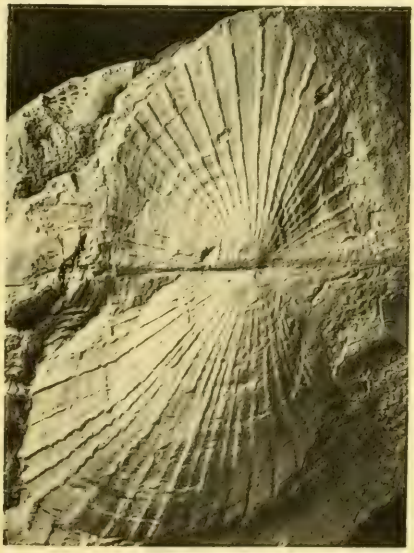

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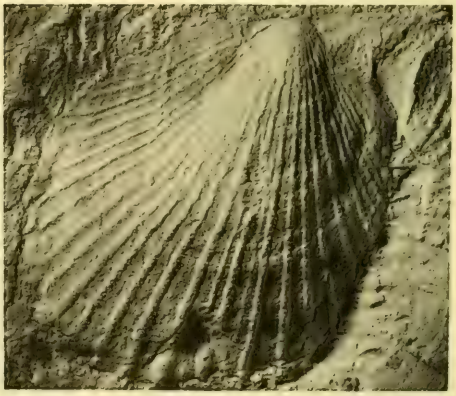

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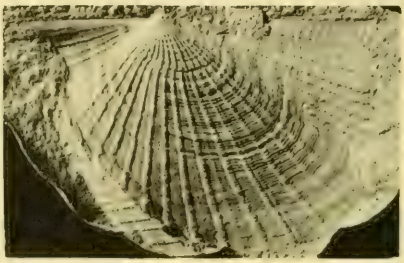

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PLATE 24

All figures are X1.

Figs. 1-7. *Vertumnia reversa* (Hall) ..... p. 56

1, 2.—Original figure and photograph of holotype, AMNH 6075/1, from "Chemung River, Upper Narrows, New York." 3.—Latex cast of YPM 21572 (collected by E. I. Leith), Loc. 66, a fragmentary right valve. 4.—The specimen figured by Hall (1884c) as fig. 24 of pl. 84, AMNH 6075/2, from "Elmira, New York." 5.—YPM 21573 (collected by E. I. Leith), Loc. 22. 6.—YPM 21574, Loc. 75. 7.—Latex cast of the holotype of *Vertumnia avis* (Hall), AMNH 6074/1:1, from "near Elmira, New York."

PLATE 25

All figures are X1 except fig. 6 (X1.5).

Figs. 1-7. *Grammysioidea subarcuata* (Hall and Whitfield) ..... p. 58

1, 2.—Holotype, AMNH 6150/3, from "near Elmira, New York," a specimen preserving both valves in articulation. 3.—YPM 21575, Loc. 103, ventral view of articulated valves showing lunule. 4.—A previously unfigured specimen from Hall's collection, AMNH 6150/8, from "Chemung Upper Narrows, New York," dorsal view of articulated valves showing the umbones. 5, 6.—The specimen shown by Hall (1885) as fig. 15 of pl. 61, AMNH 6150/4, from "near Elmira, New York." Fig. 6 is a view of the cardinal hinge region showing the umbo. 7.—The specimen shown by Hall (1885) as fig. 12 of pl. 61, AMNH 6150/2, from "Chemung, New York."

Fig. 8. *Grammysioidea* sp. ..... p. 59

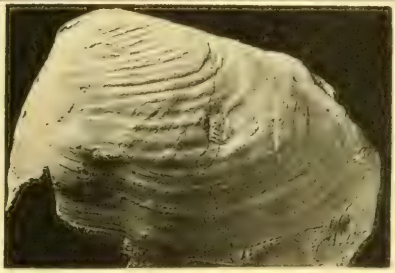
8.—YPM 21576, Loc. 23A, dorsal view of articulated valves.

Fig. 9. *Grammysia* sp. ..... p. 61

9.—Latex cast of YPM 21577, Loc. 89.

Figs. 10-12. *Grammysia elliptica* Hall and Whitfield ..... p. 60

10.—Latex cast of YPM 21578, Loc. 38. 11.—YPM 21579, Loc. 38. 12.—YPM 21560, Loc. 34.



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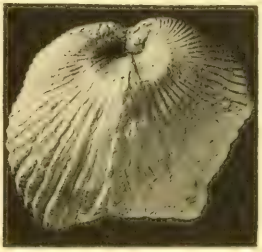

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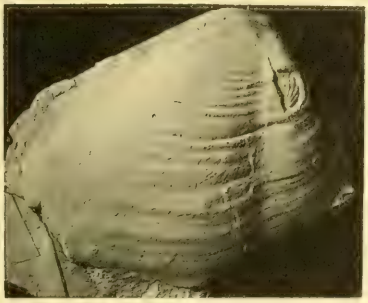

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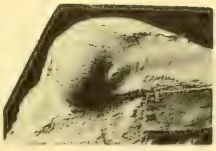

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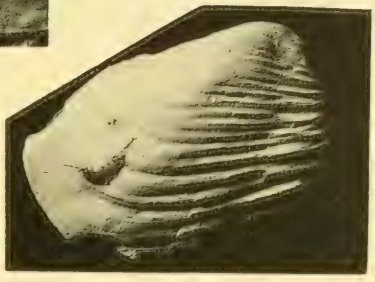

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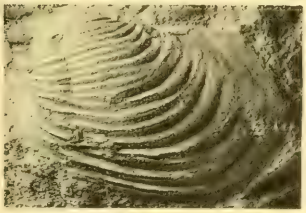

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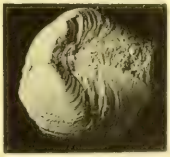

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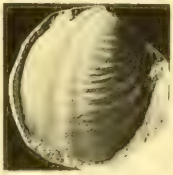

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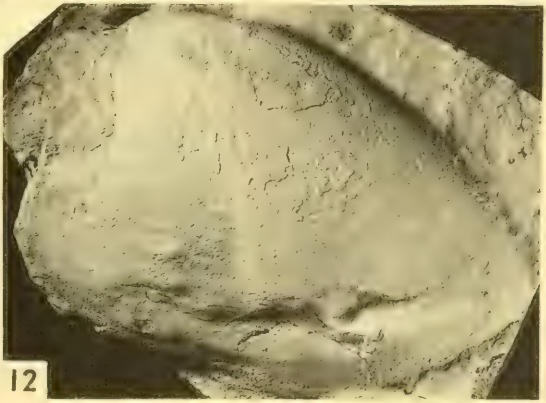

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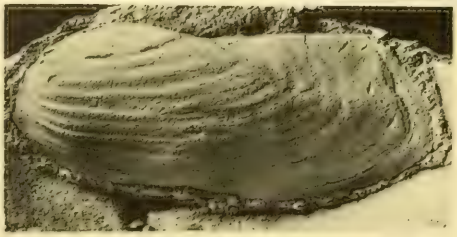

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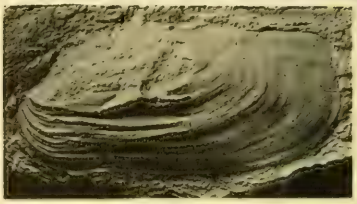

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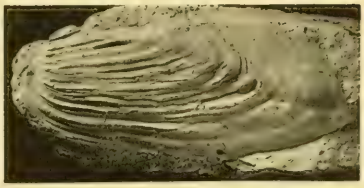

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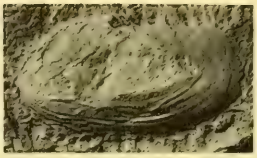

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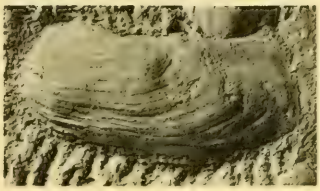

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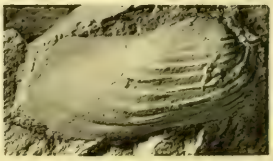

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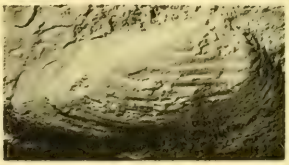

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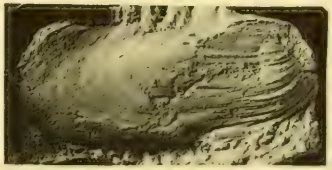

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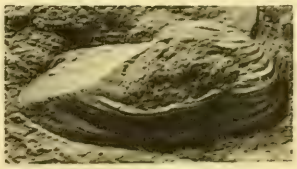

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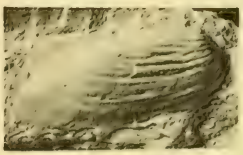

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PLATE 26

All figures are X1.5 except figs. 15 and 16 (X1).

Figs. 1-14. *Sphenotus tiogensis,* n. sp. ..... p. 62

1.—Holotype, YPM 21561, Loc. 86. 2.—YPM 21562, Loc. 102. 3.—YPM 21563, Loc. 75. 4.—YPM 21564, Loc. 102. 5.—YPM 21565, Loc. 34. 6.—YPM 21566, Loc. 34. 7.—Latex cast of YPM 21567, Loc. 35. 8.—YPM 21568, Loc. 34. 9.—YPM 21569, Loc. 34. 10.—YPM 21570, Loc. 94. 11.—Latex cast of YPM 21571, Loc. 35. 12.—Latex cast of YPM 21572, Loc. 102. 13.—Latex cast of YPM 21573, Loc. 35. 14.—YPM 21574, Loc. 23B.

Figs. 15, 16. *Cimitaria angulata* Hall ..... p. 63

15.—A previously unfigured specimen from Hall's collection, NYSM 11402, from "Chemung [Lower?] Narrows, Tioga County, New York." 16.—Holotype, NYSM 2295, from "between Elmira and Waverly, Tioga County, New York." [Both specimens were probably found at Loc. 66 of this report.]

PLATE 27

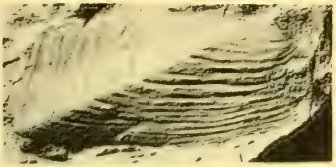
All figures are X1 except fig. 1 (X1.5).

Fig. 1. *Sphenotus* sp. ..... p. 62

1.—Holotype of *Orthonota rigida* Hall, AMNH 6185/1, from "near Elmira, New York."

Figs. 2-21. *Edmondia philipi* Hall and Whitfield ..... p. 64

2, 3.—Hall's figure and photograph of holotype, AMNH 6171/1:1, from "Philipsburgh [now Belmont], New York" (Cassadaga stage). 4.—YPM 21575, Loc. 34. 5.—YPM 21576, Loc. 34. 6.—YPM 21577, Loc. 86. 7.—YPM 21578, Loc. 30. 8.—YPM 21579, Loc. 96. 9.—YPM 21580, Loc. 87. 10.—YPM 21581, Loc. 66. 11.—Latex cast of YPM 21582, Loc. 22. 12.—YPM 21583, Loc. 86. 13.—YPM 21584, Loc. 66. 14.—Latex cast of YPM 21585, Loc. 87. 15.—YPM 21586, Loc. 66. 16.—YPM 21587, Loc. 22. 17.—Latex cast of YPM 21588, Loc. 87. 18.—YPM 21589, Loc. 22. 19.—YPM 21590, Loc. 66. 20.—YPM 21591, Loc. 87. 21.—YPM 21592, Loc 22.



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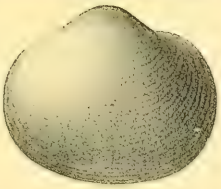

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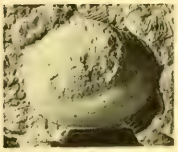

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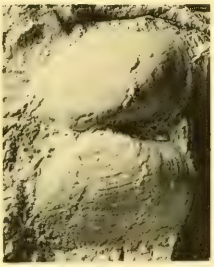

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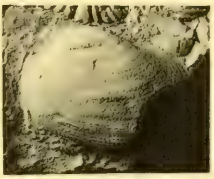

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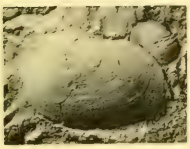

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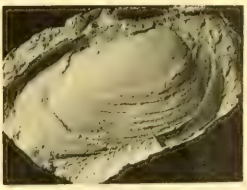

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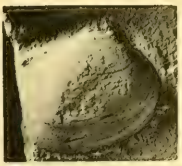

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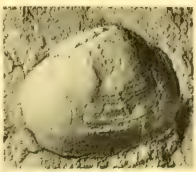

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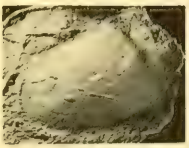

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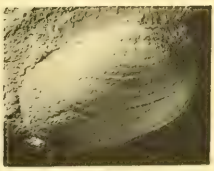

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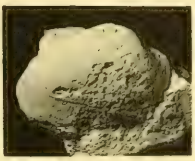

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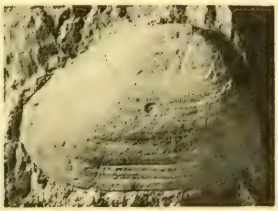

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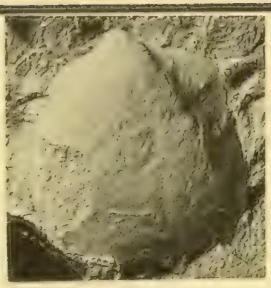

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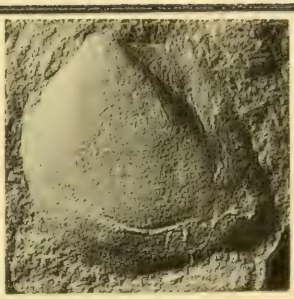

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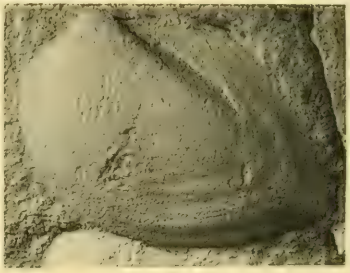

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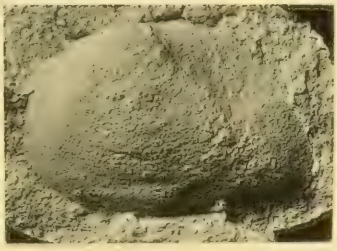

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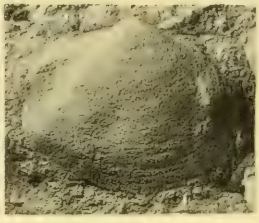

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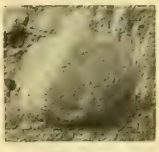

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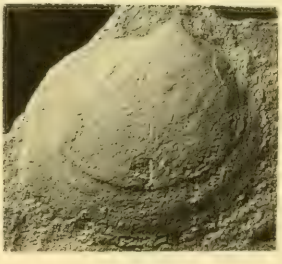

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PLATE 28

All figures are X1.

Figs. 1-12. *Eoschizodus*? *chemungensis* (Conrad) ..... p. 66

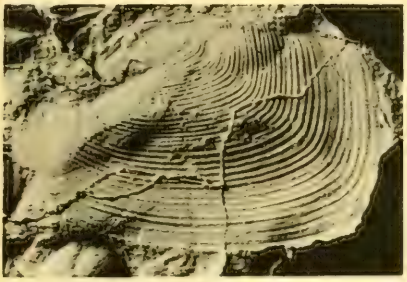
1.—The specimen shown by Hall (1885) as fig. 33 of pl. 75, AMNH 6157/1:1, from "near Elmira, New York." 2.—Latex cast of YPM 21593, Loc. 66. 3.—The specimen shown by Hall (1885) as fig. 40 of pl. 75, AMNH 6156/2:1, from "three miles north of Factoryville, Tioga County, New York." 4.—Latex cast of YPM 21594, Loc. 22. 5.—YPM 21595, Loc. 33. 6.—YPM 21596, from "Lindley, New York" (from an early YPM collection, collector unknown). 7.—The specimen shown by Hall (1885) as fig. 37 of pl. 75, AMNH 6156/2:2, from "three miles north of Factoryville, Tioga County, New York." 8. —YPM 21597, Loc. 66 (collected by E. I. Leith). 9.—The specimen shown by Hall (1885) as fig. 32 of pl. 75, AMNH 6157/1:2, from "near Elmira, New York." 10.—Holotype of *Cytherodon (Schizodus) quadrangularis* Hall, AMNH 6157/2, from "Tioga County, New York." 11.—Holotype of *Paracyclas rotunda* (Hall), NYSM 2986, from "Kirkwood, Broome County, New York." 12.—YPM 21598, Loc. 87.

PLATE 29

All figures are X1.5.

Figs. 1-8. *Cypricardella bellastriata* (Conrad) ..... p. 68

1.—Latex cast of YPM 21599, Loc. 74. 2.—YPM 21600 (collected by E. I. Leith), Loc. 66. 3.—YPM 21601 (collected by E. I. Leith), Loc. 66. 4.—YPM 21602, Loc. 73. 5.—YPM 21603 (collected by E. I. Leith), Loc. 66. 6.—YPM 21604 (collected by E. I. Leith), Loc. 66. 7.—YPM 21605 (collected by E. I. Leith), Loc. 66. 8.—YPM 21606, Loc. 103.



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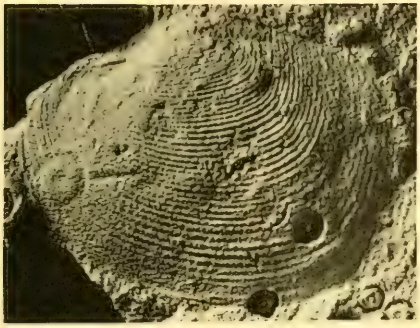

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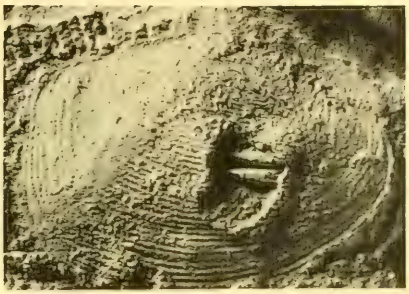

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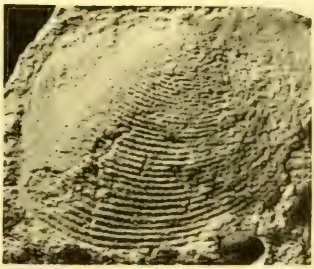

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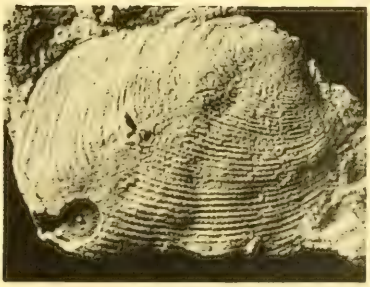

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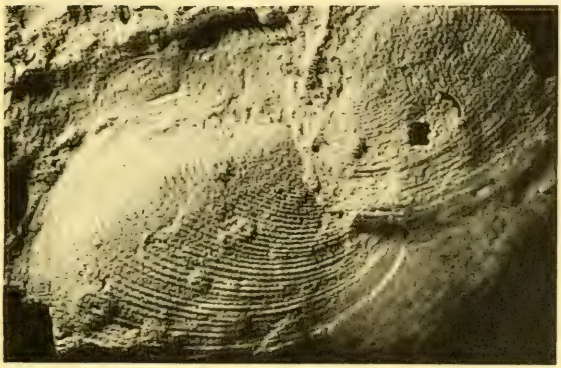

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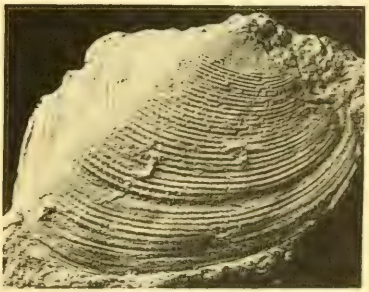

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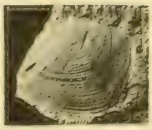

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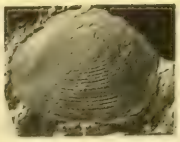

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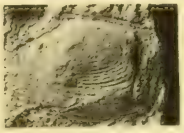

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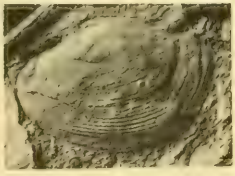

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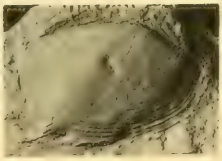

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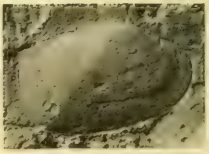

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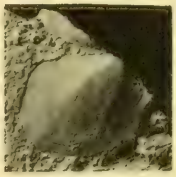

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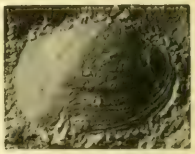

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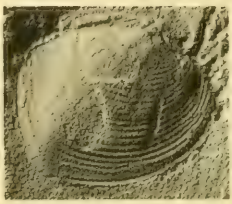

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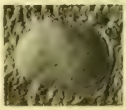

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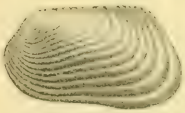

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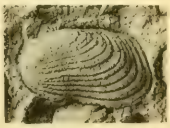

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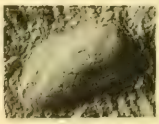

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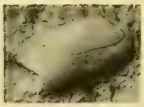

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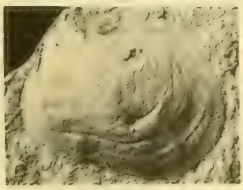

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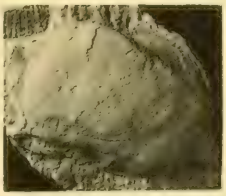

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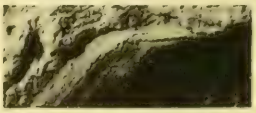

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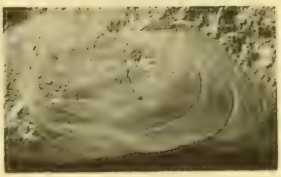

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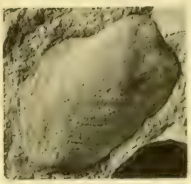

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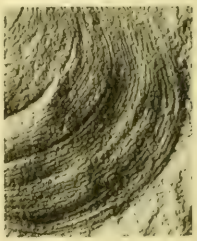

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PLATE 30

All figures are X1.5 except fig. 12 (X2) and figs. 20 and 23 (X3).

Figs. 1-11. *Cypricardella bellastriata* (Conrad) ..... p. 68

1.—YPM 21607, Loc. 23B. 2.—YPM 21608, Loc. 75. 3.—YPM 21609, Loc. 22, showing impression of hinge plate. 4.—YPM 21610, Loc. 23A, showing impression of hinge plate and anterior muscle scar. 5.—Latex cast of YPM 21611, Loc. 23A, showing faint impression of hinge plate. 6.—YPM 21612, Loc. 23A, showing impression of anterior muscle scar. 7.—YPM 21613, Loc. 94. 8.—YPM 21614, Loc. 22. 9.—YPM 21615, Loc. 87. 10.—YPM 21616, Loc. 75. 11.—YPM 21617, Loc. 86, showing impression of anterior muscle scar.

Figs. 12, 13. *Cypricardinia* sp. A ..... p. 71

12, 13.—Original figure and photograph of holotype of *Cypricardinia arcuata* Hall, NYSM 2341, from "near Elmira, New York."

Figs. 14-17. *Cypricardinia*? sp. B ..... p. 71

14.—YPM 21618, Loc. 23B. 15.—YPM 21619, Loc. 23B. 16.—YPM 21620, Loc. 73. 17.—YPM 21621, Loc. 23B.

Figs. 18-23. *Cypricardinia larocquei*, n. sp. ..... p. 70

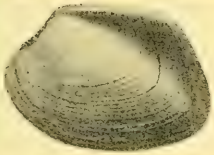
18, 23.—Latex cast of holotype, YPM 21622, Loc. 60. Fig. 23 is an enlargement showing surface sculpture. 19.—YPM 21623, Loc. 60. 20, 21.—YPM 21624, Loc. 60. Fig. 20 is an enlargement of a latex cast of the posterior hinge region showing the strong lateral tooth of the left valve. 22.—Latex cast of YPM 21625, Loc. 60.

PLATE 31

All figures are X1.5 except fig. 1 (X1) and figs. 18 and 19 (X3).

Figs. 1-19. *Cypricardella gregaria* (Hall and Whitfield) ..... p. 69

1, 2.—Hall's figure and photograph of holotype, AMNH 6154/1:1, from "Cortland, New York" (probably Finger Lakes stage). 3.—YPM 21631, Loc. 38. 4.—YPM 21632, Loc. 38. 5.—YPM 21633, Loc. 38. 6.—YPM 21634, Loc. 30. 7.—YPM 21635, Loc. 30. 8.—YPM 21636, Loc. 30. 9.—YPM 21637, Loc. 35. 10.—Latex cast of YPM 21638, Loc. 30. 11.—YPM 21639, Loc. 38. 12.—Latex cast of YPM 21640, Loc. 30. 13.—YPM 21641, Loc. 38. 14.—Latex cast of YPM 21642, Loc. 30, an internal view of a right valve showing the anterior muscle scar. 15, 18.—YPM 21643, Loc. 30. Fig. 18 is an enlargement of a latex cast of the hinge plate impression showing a single large cardinal tooth in the left valve. 16.—YPM 21644, Loc. 38. 17.—Latex cast of YPM 21645, Loc. 38, dorsal view of articulated valves. 19.—Latex cast of YPM 21646, an enlargement of a hinge plate of a right valve showing the dental socket and ligament groove.



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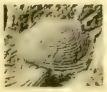

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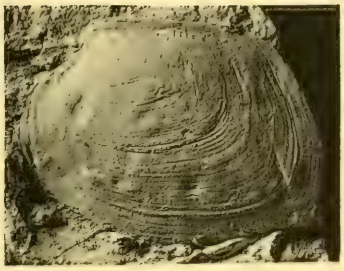

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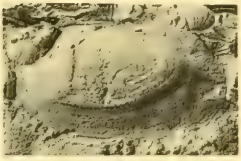

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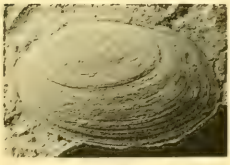

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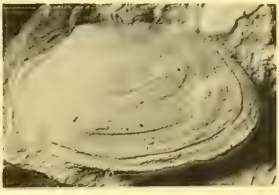

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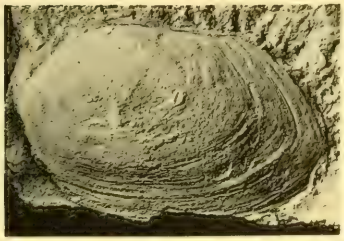

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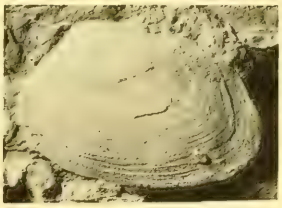

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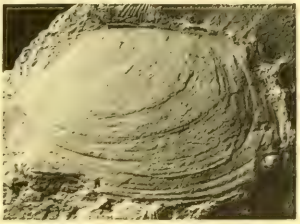

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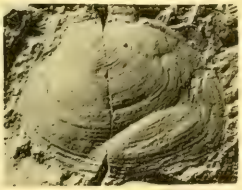

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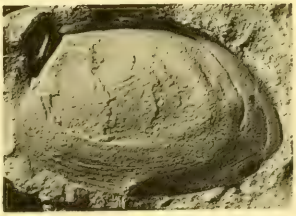

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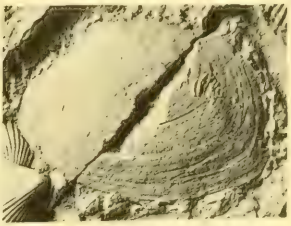

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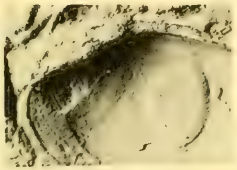

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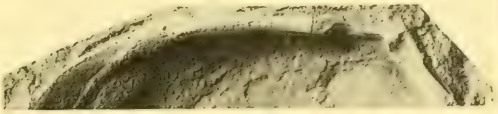

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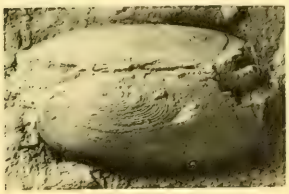

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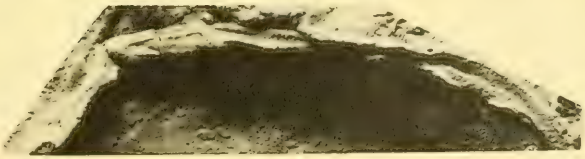

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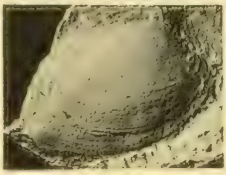

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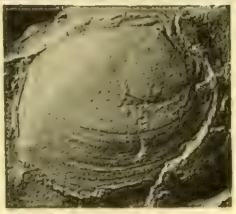

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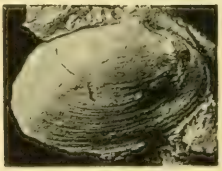

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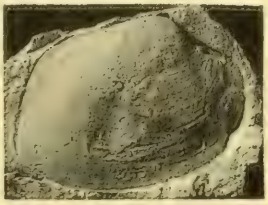

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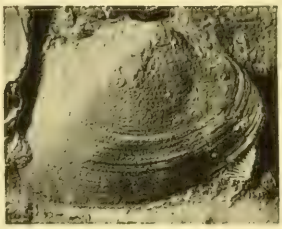

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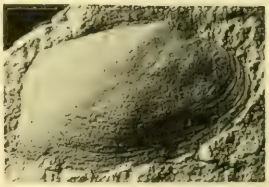

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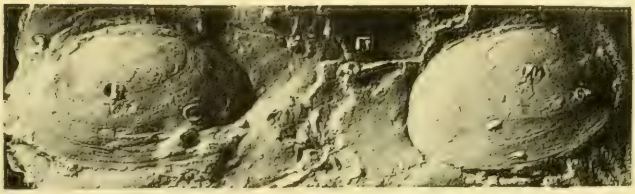

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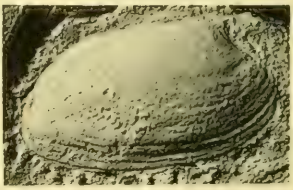

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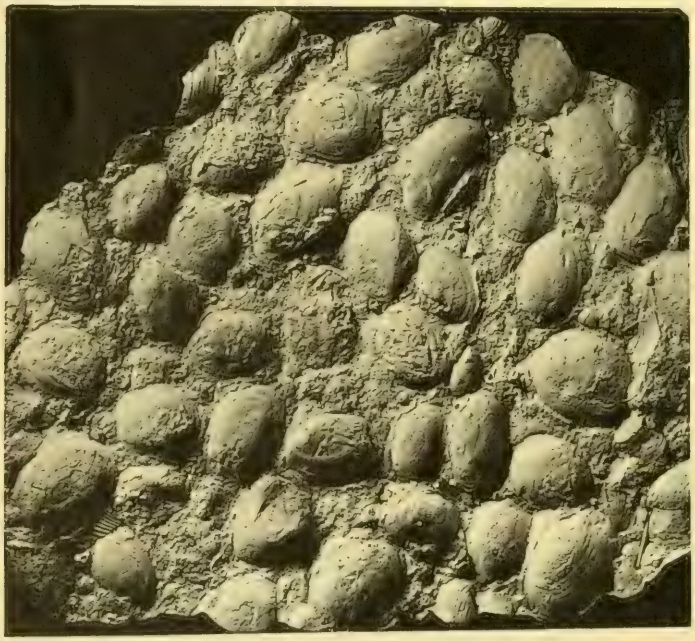

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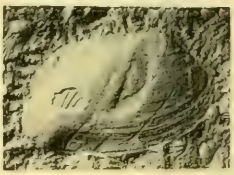

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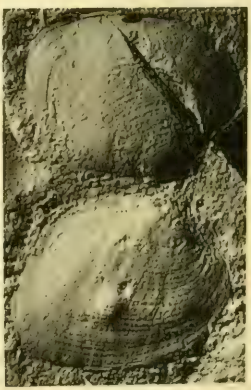

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PLATE 32

All figures are X1.5 except fig. 10 (X 3/4).

Figs. 1-12. *Cypricardella gregaria* (Hall and Whitfield) ..... p. 69

1.—YPM 21647, Loc. 38. 2.—YPM 21648, Loc. 38. 3.—YPM 21649, Loc. 35. 4.—YPM 21650, Loc. 35. 5.—YPM 21651, Loc. 30. 6.—Latex cast of YPM 21652, Loc. 30. 7.—YPM 21653, Loc. 38. 8.—Latex cast of YPM 21654, Loc. 35. 9.—YPM 21655, Loc. 38. 10.—Latex cast of YPM 21656, Loc. 35, showing shape variation on a single slab. 11.—YPM 21657, Loc. 38. 12.—YPM 21658, Loc. 30.

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